HARMONIES OF NATURE,

BY

J. B. H. DE SAINT-PIERRE;

BEING

A SEQUEL

TO HIS

STUDIES OF NATURE.

IN THREE VOLUMES.

WITH A PORTRAIT,

AND A

PREFATORY ACCOUNT OF THE AUTHOR, AND THE WORK.

BY LOUIS AIMÉ-MARTIN.

——— Miseris succurrere disco. ÆN.

TRANSLATED

BY W. MEESTON, A.M.

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AQUATIC HARMONIES.

INSPIRE me, gentle Naiads, who scatter silver waves on the earth! Come to my aid, ye Nereids, who exhale them in vapours to heaven, and receive them in the basins of the sea! I was born on your banks. How often have I passed the live-long day on your solitary shores, complaining only to you and to heaven of the unjust treatment of my fellow-creatures! Your sighs appeared to re-echo my complaints. Often seated at the foot of a rock have I waited to contemplate your storms, an image of the storms which I experienced in life. My eyes, moistened with tears, followed in your horizon a distant sail which wafted an ill-starred friend to other regions. I have gone in a variety of climates across your liquid plains, in quest of that happiness which I have found as inconstant as your waves. Fortune, wherever I have gone, has proved as deceitful as men; but Nature every

where beneficent and unchanged. It was the powerful agency of water that levelled the earth, that excavated the vallies, and that rounded the hills; it was on your verdant shores, in the bosom of your azure waves, and in the midst of that night which till then had been perpetual, that Venus came forth, bathed in your transparent waters, and resplendent with the beam of the morning. Come forth and animate me with those beams, brilliant orb of day! light, warmth, colour, shape, motion, and all the harmonies of life, are produced under thy shining rays. Now that my short-lived course is on the decline, enlighten the evening of my days with an illumination from thy perpetual splendour. Draw me from this world of clay towards the Divinity, of whom thou affordest the most striking image. Inspired by thee and by the beauty of the various objects of nature, may my words appear instructive in the eye of the learned, and affecting to the heart of the humbler part of mankind! . . . . .

Aquatic Harmonies of Air.

It is altogether to the vapours of water that the atmosphere is indebted for the rich colours, and for the splendid appearance of the clouds, which form the beauty of the sky. If these vapours had no existence, the sun would appear to us considerably smaller in the midst of a dark blue sky, and would appear to us exactly as to a spectator on the top of a lofty mountain. Nothing can be more monotonous than a sky without clouds.

It is to the aquatic vapours of the air, which decompose the solar rays, that the morning is indebted for the magnificence of its colouring. That colouring first appears on the horizon in the white which indicates pure light, and has received in French the name of *aube*, from the Latin *alba*. The white, as it rises above the horizon, becomes decomposed into different shades of yellow, which gradually assume the appearance of gold yellow, the general colour of the solar rays in our atmosphere. This gold yellow, heightened by a vermilion tinge, forms the colour of the dawn, and rises subsequently through different tints of red to carmine in the zenith; whence descending, by shades of purple and violet, it becomes blue toward sun set, and finally

changes from blue to black, when the night has thrown her shade completely around. These five primitive colours, and their principal shades, appear to be shared among the principal powers in nature; white belonging to the sun, blue to air and water; yellow to the earth; green to vegetables; red to the blood of animals; and colours of all kinds to man, from the white of northern nations to the black of the inhabitants of the torrid zone. It is equally remarkable that those primitive colours have been adopted by different nations in a geographical order, which strikes me as bearing some connexion with the atmospherical order just mentioned. Thus the Chinese, situated in the east, give a preference to the yellow of the morning; the Africans, the inhabitants of the south, to the red; while the nations of the west of Europe are disposed to prefer the blue. The inhabitants of Thibet are understood to have a predilection for orange; the Russians for green; the Italians for violet; at least these are the imperial, royal, and distinctive colours of these nations. White and black, by their marked contrast, are the colours of mourning among different parts of mankind; the white among dark coloured nations, and the black among those that are fair. —In the sky, as in the human countenance, all the primitive colours are found to harmonize;

rain exhibits them assembled in the beauteous rainbow, as if the fall of a few drops of water were sufficient for their formation.

If the aquatic vapours dispersed throughout the air decompose the solar rays into an infinity of colours, and describe even a segment of his circumference when they come down in the shape of rain, they are found to represent sometimes the sun himself entire, and in complete splendour, when they are in the form of a cloud; I mean when they assume the image called parhelion or mock sun. Appearances of this description are common only on frozen seas, where they conduce greatly to accelerate the melting of the polar ice in summer; for Nature, we find, has made nothing in vain. Martenz, who visited Spitzbergen, and had observed them frequently in such situations, says that they are of dazzling brilliancy, and have more heat than the sun himself. In this there is nothing improbable, since they collect his rays on a large diameter, and operate in the manner of a burning mirror.

Parhelia are in a manner confined to the frozen zones, being seldom observed in the temperate, and never in either of the two torrid zones. The reason may be easily conceived: the parhelia, which melt the ice of the polar oceans in the north and south, would kindle a destructive flame were

they permitted to display their power on the forests of the torrid zone. No doubt, therefore, as to the sufficiency of the cause: but it is less easy to discover by what means it happens that they are not formed in the clouds of the torrid zone, since the number of the latter is great, and indeed the major part of the clouds which fill the atmosphere take their rise in that central part of the globe, whence they are propelled all the way to the poles.

I cannot help thinking, however, that it is not altogether impracticable to account for this difference of effect. In our summers the clouds, expanded by heat, extend horizontally throughout a dilated atmosphere; while in the icy seas, as with us in winter, the clouds, compressed with cold, rise perpendicularly and obliquely into a condensed atmosphere. The consequence is that the horizontal clouds of warm countries and seasons give little solar reflection, and a great deal of shade; while the perpendicular or oblique clouds of icy regions or seasons cast little shade on the earth, and a great deal of solar reflection.

These differences in the degree of reflection are perceptible in our climates, not only in the course of the year, but even in that of the day. When the sun is, in the morning, at the horizon,

he spreads his light on the clouds, and gives rise o the rich colouring of the dawn. At noon he enlightens them from above, at which time the clouds are without colour, and cast a great deal of shade; but when he is going down in the west his splendour is still brighter than in the morning, in consequence of his having raised a number of vapours during the day.

It follows that parhelia, like rainbows, are formed only when the sun is little elevated above the horizon. This being the case, the clouds of the icy seas are formed in summer out of the fogs, which rise perpendicularly, and with little expansion, from that part of the ice which is melted. They reflect in their cavities the rays and even the disk of the sun in the same way as the ice from which they proceed, and which is then of a dazzling splendour. They throw out such a heat in the atmosphere, that Martenz declares they melted the tar in his ship by the power of their reflection. Those perpendicular and oblique clouds, not unlike in shape to ranges of lofty mountains, descend in the month of March from the northern pole into our atmosphere. They conduce by their reverberation to the strokes of the sun (*coups de soleil*), so frequent in that month, by augmenting the power of his rays on the earth

stiffened by the cold of winter. On the other hand, the clouds brought to us by the south wind from the torrid zone are dark, widely extended in the sky, and cast a great shade along the earth. Nature has given to the clouds of the warm and cold zones the same shape and arrangement as to the leaves of their vegetables, which in the one are horizontal, and serve as parasols, while in the other they are perpendicular and operate as reflectors. This, as I have already mentioned, is the reason why the palm tree of Africa spreads forth its boughs, while the fir of Russia raises its branches in a pyramidal form.

Not only do the clouds, when condensed by cold, and when perpendicular or oblique with reference to the horizon, send forth a reflection and sometimes an image of the sun; but it is very possible that, when in a horizontal position, they may exhibit to us the image of terrestrial objects. The mountains, the forests, and the armies, which are said to be occasionally seen in the clouds, are consequently more of real pictures than we are apt to imagine.

I can bring some curious facts to the support of this apparent paradox. Some time after I had published the "Studies of Nature," a person came to tell me that he had discovered the secret

of announcing the approach of ships when at a distance of sixty or eighty leagues from port. He had, he assured me, exemplified the thing repeatedly in the Isle of France, in the presence of several witnesses, who had signed his memorial, and he was desirous of getting it presented to the Minister of Marine, that his plan might be adopted in France. He applied to me to affix explanatory notes to his memorial, supposing that, from my having gone as engineer to the Isle of France, I must have heard his discovery mentioned, and could not fail to be aware of its practicability in consequence of my attention to the study of nature. He imagined that my success as an author, partial as it had then been, must give any representation from me a great deal of weight at a public office. I replied that, when at the Isle of France, I had heard it said that tropic birds announced the approach of ships from Europe by preceding them a great way, and by settling on the island before the ships reached the coast; but that I was entirely a stranger to the observations which he had made personally. I added that I was a retired student, unknown to public boards, and that, moreover, he had no need of any assistance to reduce his discovery to practice, since a mere trial, and the evidence of respectable wit-

point of the compass into the mountains. But how great was his surprise on finding, at the distance of seven leagues from the spot, the town of which he had seen the reflection in the sky, and of which he had a sketch in his portfolio.

The reflection of a town in the sky is however by no means more extraordinary than the phenomenon known by the name of Feé Morgane in the Straits of Sicily. All travellers who have visited this part of the island speak of it with admiration. Brydone makes the following observations on it in the fourth letter of his Tour.

"It has often been remarked, both by the ancients and moderns, that in the heat of summer, after the sea and air have been much agitated by the winds, and a perfect calm succeeds, there appears, about the time of dawn, in that part of the heavens over the Straits, a great variety of singular forms, some at rest and some moving about with great velocity. These forms, in proportion as the light increases, seem to become more aërial, till at last, some time before sun-rise, they entirely disappear.

"The Sicilians represent this as the most beautiful sight in nature; Leanti, one of their latest and best writers, came here on purpose to see it: He says, the heavens appeared crowded with a variety of objects: he mentions palaces, woods,

gardens, &c. besides the figures of men, and other animals, that appear in motion amongst them. No doubt the imagination must be greatly aiding in forming this aërial creation; but as so many of their authors, both ancient and modern, agree in the fact, and give an account of it from their own observation, there certainly must be some foundation for the story. There is one Giardini, a Jesuit, who has lately written a treatise of this phenomenon, but I have not been able to find it: The celebrated Messinese Gallo has likewise published something on this singular subject; if I can procure either of them in the island, you shall have a more perfect account of it. The common people, according to custom, give the whole merit to the devil; and indeed it is by much the shortest and easiest way of accounting for it. Those who pretend to be philosophers, and refuse him this honour, are greatly puzzled what to make of it. They think it may be owing to some uncommon refraction or reflection of the rays from the water of the Straits; which, as it is at that time carried about in a variety of eddies and vortexes, must consequently, say they, make a variety of appearances on any medium where it is reflected. This, I think, is nonsense; or at least, very near it; and till they can say more to the purpose, I think they had much better

have left it in the hands of the old gentleman. I suspect it is something in the nature of our Aurora Borealis, and, like many of the great phenomena of Nature, depends upon electrical causes; which in future ages, I have little doubt, will be found to be as powerful an agent in regulating the universe, as gravity is in this age, or as the subtile fluid was in the last.

"The electrical fluid, in this country of volcanoes, is probably produced in a much greater quantity than in any other. The air strongly impregnated with this matter, and confined betwixt two ridges of mountains; at the same time exceedingly agitated from below by the violence of the current, and the impetuous whirling of the waters; may it not be supposed to produce a variety of appearances?"

It is vexatious that Mr. Brydone should not have personally observed these extraordinary effects during his stay at Messina. As an Englishman, he is entitled to much credit for venturing to dissent from the authority of his countryman, Newton, and for attributing to electricity several phenomena evidently dependent on it, such as the Aurora Borealis and the long tails of comets, both ascribed by the Newtonians to attraction, which according to them is the universal law of nature. At the same time I

think that he ought not to have rejected with contempt the plain solution of the Sicilian philosophers. It seems extremely probable that, were even electricity the cause of the phenomena perceived above the Straits of Sicily, the reflection of these Straits would accompany it, and be made apparent in the sky by the undulations of the water, the images of forests, castles, &c. Brydone is himself of this opinion, since he attributes these aërial movements to the *impetus* of the waves below; but he falls into an error in attributing this species of Aurora Borealis to the volcanic vapours of Sicily; for it is clearly ascertained that the polar regions, which transmit to us in winter such magnificent Auroræ, have no volcanoes amid their glaciers.

I frequently observed in Russia an Aurora Borealis extending occasionally beyond the latitude corresponding to that of Paris; and varying from white to blue, green, red, radiating and fluctuating. I am much inclined to attribute this variety of colour, and the movements of the Aurora, to the reflection of the polar ice; of the fir forests of the north; of the iron and red-streaked mines of Siberia; as well as to the undulations of the ocean reflected in the sky. I am confirmed in this notion by the Aurora

Australis, so often observed by Captain Cook being white and blue without the admixture o any other colour. This uniformity proceeded no doubt, from the reflection being confined t the ice of the ocean in the southern hemisphere which is well known to have no surroundin continent. These Auroræ take place at each pol only when the sun is under their horizon; tha is, during the course of their winter, and th same remark is applicable to the Straits of Sicily the phenomenon in question being perceive there only at the latter part of the night an before sunrise. It is clear therefore that suc phenomena arise from a vapoury atmospher condensed by cold; which reflects at the sam time the objects of the earth and the light of th sky. Such reverberations must be frequent in a atmosphere of icy mountains like the Alps an Appennines; and Vernet in fact observed then there. From all this it seems to me possibl that the person I have lately mentioned ma have succeeded in discovering a vessel at a grea distance from the Isle of France by means of th condensed atmosphere of the Isle of Bourbon which is one hundred miles off, and the summit of which are always covered with ice. The sam reasoning suggests an explanation of his failur

at Brest, in the horizon of which there are no mountains of that description, and consequently no vapours likely to produce the effect.

Aquatic vapours do not merely decompose the sun's rays into colours, and reflect his circumference in the rainbow, as well as his entire disk in parhelia, they absorb likewise a portion of his heat, and impart it to the earth in fertilizing showers. Water thus becomes, however odd it may sound, a vehicle for fire. The ocean of vapours which fill the atmosphere contains the total supply of water for our rivers, and, were it to fall at once from the sky, would spread havoc throughout the surface of the globe; but it is ordained that its fall shall generally take place in gentle and innoxious showers. The water of the atmosphere is the matrix of that electric, or, to speak more properly, of that solar fire generally invisible, which fertilizes and vivifies the universe. It is through the medium of a shower, as through a conductor, that it comes down from the clouds which contain it; in fact, we never observe thunder without clouds. The ancients indeed alleged that it did occasionally thunder in fine weather, and Pliny, who relates this phenomenon, adds that it was accounted the presage of something great. It is doubtful whether any thing of this kind actually took place, but there is no doubt

that lightning sometimes proceeds from the bosom of the earth; and this was what the ancients, agreeably to the testimony of the same author, were accustomed to call "lightning from the infernal regions." A phenomenon of this kind takes place when a metallic portion of the globe, insulated on a vitreous or sulphureous rock, is loaded more heavily with electric fire than the atmosphere which corresponds to it. Being unable to expand itself within, on account of the anti-electric quality belonging to glass and sulphur, it strikes outwards towards an attracting cloud; so as to attain the equilibrium already alluded to in our observations on electricity, by passing from a body which has more to one which has less. It is on this principle that we have adopted the electric rods which protect our public buildings from lightning. It was in a piece of amber that the electric property was first perceived, and from this small beginning did man proceed to devise the means of bringing down lightning from heaven.

A proof that electric fire proceeds from the sun is to be found in the well known fact that we have very little thunder in winter, the season when the action of the solar heat is comparatively small on our hemisphere. It deserves likewise to be remarked that thunder-showers, which are

replete with this electric fire, accelerate very considerably the progress of vegetation, and the hatching of the eggs of insects. Thunder is, in almost every part of the world, the forerunner of spring; that is, of the action of the sun on vegetation. In Russia the people never consider the spring begun till after they have heard thunder; while in France we have a current proverb among the peasantry, "that when it thunders in April, the heart of the countryman is glad." Yet many of them are apt to consider this brilliant meteor as a sign of the anger of God with men; and ring the bells of their villages in the hope of averting it. Examples have not been wanting of their bringing it to the steeples in which they were ringing, the iron cross operating as an attractor. Thunder, so far from being a token of the anger of God, is a proof of his bounty. It clears the atmosphere by making its upper part, which is always cold, fall into its lower part, at a time when the latter is too much heated by the reflection of the earth. It pours, moreover, on the latter a supply of water, tepid, sulphureous, and nitrous, which is highly fertilizing. True it is that its bright flashes, and its rolling accompanied by peals, are in no small degree alarming; but nothing in the works of Nature is made in vain. As this rapid communication of the fire of the clouds to the

earth is dangerous to those who might happen to encounter it, the noise is a warning to animals to place themselves under shelter. It is often accompanied with another meteor, I mean hail, which is injurious to vines and corn-fields, but fatal at the same time to insects, whose numbers might otherwise be increased by the consequences of stormy weather. Hail, like thunder, is announced by an alarming noise, and by a kind of distant clashing, which gives man at least an opportunity of withdrawing from its range. Every thing, moreover, has its counterpoise; the countries most subject to storms are the most fertile, and the same may be said of those which are adjacent to volcanoes, these thunders of the earth and seas.

It is then to the aquatic harmonies of the air, called into action by the sun, that we are indebted for the decomposition of light into a thousand tints; for showers which fertilize our fields, and feed our rivers, as well as for rainbows; for the renovating thunder storms of the torrid zone; and the parhelia of icy regions.

It is to produce those different effects that the sun incessantly raises the waters of the ocean in vapours, collects them in clouds, disperses them in the atmosphere in ranges elevated above each other, and productive of such charming pros-

pects, particularly towards the hour of sun-set. We are in the habit of extolling the dawn greatly, and of saying very little in regard to evening. A similar animadversion is applicable to our manner of speaking of the month of May, the dawn of the vegetable year, and the month of September which brings it to a close. May is by no means to be considered as exempt from bad weather, for I have often found it humid and cold like the dawn of day, while September is dry and warm like the parting beams of the sun. The dawn of the morning, and the month of May, doubtless possess many attractions; but their great charm is in our imagination, the one announcing the beginning of day, the other the beginning of the fine season; while sun-set and the month of September are the precursors of night and of winter. While the former are emblems of youth and pleasure, the latter remind us of age and infirmity. Our moral ideas give frequently an unfair turn to our physical sensations. For my part it has been my lot to find the evening more interesting than the morning, September milder than May, and my autumn more agreeable than my spring.

When I was at sea, and at such a distance from land as to have no other objects but the water and sky, I occupied myself occasionally with sketch-

ing the beautiful white and grey clouds which rolled after each other in the azure vault like masses of mountains. It was particularly at the close of day that they displayed all their beauty, and seemed clothed in their richest colouring. On land every situation is permanent, and presents the same horizon; in the sky, every hour, or at least every evening, offers a change of scene. Of this I have endeavoured to exhibit a few sketches in the "Studies of Nature," and I shall now make a similar attempt, although well aware of the imperfection of my pencil.

One evening, about half an hour before sunset, the south-east trade wind began to fall, as generally happens at that time of day. The clouds which it drives before it in the sky, at a distance as regular as its own breeze, became thinner, while those to the westward collected into groups in the manner of a landscape. They exhibited the appearance of an extensive region consisting of high mountains, separated by deep valleys and surmounted by pyramidical rocks. On their tops and sides appeared detached mists, similar to those which arise round a real land. A long river seemed to wind through the valleys, and to fall here and there in cataracts; and the imagination was even led to conceive it to have at one place a great bridge composed of half

fallen arches. Groves of cocoa-trees, with habitations interspersed, seemed to rise on various spots of this aërial island. These different objects however were not adorned with the rich tints of purple, yellow, or emerald, so common at sun-set in these regions; this landscape was not a coloured painting, but a plain engraving uniting the harmonies of light and shade. It exhibited a country enlightened, not by the solar rays striking in front, but by their reflection from behind. Yet so soon as the orb of day had sunk behind this aërial landscape, some of its decomposed rays were perceived to lighten the half transparent arches of the bridge with a scarlet tint, and to display their reflections in the valleys and on the summit of the rocks. Floods of light covered the contour of the landscape with beautiful yellow, and diverged in rays towards the upper sky; but the body of the clouds remained under a dark half tint, while we saw around the sides of this landscape the flash of lightning, and heard from afar the rolling of thunder. So strong was the deception, that the spectator could not forbear believing that it was a real land, at the probable distance of four or five miles. It might indeed have been a reverberation in the sky of a very distant island, the shape of which might be exhibited to us by the reflection of the

clouds. Experienced seamen have repeatedly assured me that they had been deceived by similar appearances. Be that as it may, all this fantastic display of magnificence and terror, these mountains crowned with palm-trees, the storms raging on their summits, the river, the bridge, all melted away and disappeared at night-fall, as the illusions of the world vanish at the approach of death. The orb of night, the triple Hecate, which repeats by milder harmonies those of the orb of day, rose on the horizon, put an end to the dominion of light, and substituted that of shade. Soon did we see a multitude of stars of perpetual brightness shine in the bosom of darkness. Oh! if day itself is but an image of life; if the rapid hours of the dawn, of morning, of mid-day, and of evening, represent the transient epochs of infancy, youth, manhood, and old age; death may be expected to exhibit to our view, like night, a new sky and a new world.

Harmonies of Water.

ALTHOUGH water be subject to evaporation, and occupy in that state a space wonderfully larger than in its natural state, it does not however admit of compression. It is in vain to make effort after effort, for no human power can force its particles to enter into each other as we do with those of air. Water closely compressed in a tube of metal will burst the tube, if of iron, and will pass through its pores if of gold. Moreover, vapours of water arise in the most dilated air without becoming blended with it. We must not however conclude that water is altogether incompressible; Nature possesses means unknown to us, and greatly superior to our mechanical instruments. She condenses air in the oak to such a degree as to enclose a quantity not inferior to the third part of the weight of the wood, agreeably to the chemical experiments of Homberg, which we have already noticed. It appears that she compresses water in trees in a still greater proportion. Although wood appears even in the inside to be in a very dry state, it evidently contains a large quantity of water, from the smoke that comes out of it on being burned. A quantity of wood of the weight of a ton gives

hardly twenty pounds' weight of ashes; so that the large evaporation that must have taken place must have consisted chiefly of air and water, combined there under a solid form. There is, however, a difference between the air and water, even when in this state of intimate combination; the air going out invisibly indeed, but often with noise and hissing, while the watery part comes out in silence under the form of a dark vapour. Wood encloses likewise a portion of the direct material of fire, generated by a combination of the rays of the sun which strike on it, and which, by a process still more extraordinary, acquire consistency in it, fix themselves there invisibly, and come forth in fire and flame at the time of putting the wood in the fire.

We have seen that water, when reduced into vapour, refracts the rays of the sun, and decomposes them into colours. When in a fluid state it reflects them on the outside, and at the same time it apparently reflects in the inside all the objects which surround it, and which, as is well known, transmit in all directions coloured rays which render them visible. I say that water reflects apparently in the inside the objects surrounding it; for that reflection takes place only at the surface, in the same way as on the surface of all smooth bodies.

I was never well able to understand in what manner water, like a mirror, admitted light within it without reflecting on the outside the shapes of coloured and luminous bodies. I comprehend the reason for these optical laws without having a proper conception of the cause, or of the mechanism by which the effect is produced. Let our doctors say what they please, we arrive at a knowledge of final causes only... It is evidently necessary that the solar rays should be reflected, and should extend their vivifying operation to the earth, for which reason water is distributed throughout the circumference of the globe, and particularly at the poles, where the snow and ice have a reverberating power, by way of counterpoise to the long absence of the orb of day. But had these waters, whether in a frozen or liquid state, reflected the images of bodies, a thousand deceitful forms would have been mixed with the real ones, and the expanse of the ocean would have reflected in the sky a new world and another sun. Our rivers would have exhibited moving forests, and hills perpendicular to their surface; a rivulet would have displayed the verdure and the flowers of a neighbouring meadow. Imagination may carry this scene farther, and conceive a shepherdess, after leading her sheep to the river side, contemplating a second flock in the water,

or recoiling with surprise on seeing in the stream a figure similar to her own. In short, the effect would have been the exhibition in the air of all terrestrial objects by reflection from the water. But by an admirable arrangement the moving surface of water is made to reflect, towards the heavens, that light which descends from them. It enlightens by its reflection the shades of neighbouring bodies, while their shapes appear sunk in its depth. It thus happens that the real and the reflected hemisphere form between them a complete sphere separated by intervening light, and harmonize instead of being confounded with each other.

It sometimes happens however that water in a liquid state exhibits the same phenomena as evaporated water. I have seen, in a tempest, the colours of the rainbow on the top of waves; and the imagination may even figure to itself parhelia in their curves, when they are hollowed into valleys by the pressure of the wind. It is by the same process that a concave mirror sends back into the air, and fixes there, the image of an object placed opposite to it. I ascribe to reverberations of this kind a blue flame which I have sometimes seen rise from the sea in the evening, at the moment when the sun's disk sinks below the horizon.

The reflection of the sun's rays is much greater on water than on land; in proof of which seamen are much more tanned than agricultural labourers in the same latitude. Strokes of the sun are of more frequent occurrence in the neighbourhood of rivers, than in the interior of the country. The reflection of water is in proportion to its degree of undulation, whence it happens that, in tempests where the sun shines forth, the sea has more heat than usual, because the waves double their surfaces, and consequently their reverberations, by means of the hollow and uneven shapes into which they are driven by the wind. If, however, there are districts in the vicinity of water, of which the atmosphere is colder than that of the neighbouring lands, the cause is to be sought in the source of the water in question, which will be found to flow from an icy mountain, or from some particularly cold quarter.

The solar rays are not only reflected by water, but will be found to penetrate a considerable way under its surface. If, as is commonly believed, the abysses of the ocean have a degree of depth equal to the height of the highest mountains in the globe, the result must be that the solar rays exercise an influence, direct or indirect, throughout a mass of water of several thousand feet in depth. Were that not the case, there would be

submarine cavities, the water of which, deprived altogether of the heat of the sun, would become congealed at certain periods, and we should see rising, in the seas of the torrid zone which are the deepest of any, glaciers of sufficient magnitude to affect the progress of vegetation in the adjoining territory. The Charib, and the Otaheitean would be arrested in their canoes by the dread of seeing those frail barks raised aloft by solid bodies emerging from the bottom of the deep. Had not the sun been enabled to communicate some portion of his heat to the deepest abyss, the indications of a frozen zone might have suddenly appeared in the neighbourhood of the equator.

If we attempt to form an idea of the contents of submarine abysses, we shall find that they are the cradle or receptacle of a number of things essential to the comfort of mankind. It was in the sea that there were first formed clay, marl, slate, marble, gypsum, flints, and even metals. These are generally found disposed in horizontal layers and filled with sea shells, which proves that they are all formed by the operation of the waters of the ocean. Again, it is on its shores that, by the continual beating of the waves and rolling of pebbles, vast strands are pulverized so as to supply that volatile sand which, when trans-

ported by the winds, serves to repair the summits of the highest mountains.

It is thus, not without reason, that the ocean has been called from the earliest ages the father of all things. We must add that it is in like manner the tomb or absorbent of all the products and materials of the earth. It is into its bosom that fragments of rocks and mountains are poured by rivers, after being received into the latter through the medium of torrents, which become, as is well known, black or yellow from the mixture brought into them by a copious fall of rain. It is into the ocean likewise that the oil, the bitumen, and the nitre of volcanoes is thrown; and that even the proudest works of man eventually disappear. A considerable part of the city of Rome is no longer on the site of ancient Rome; but at the bottom of the Tiber, or on the shoals of the Mediterranean. The remains of her innumerable population no longer lie in their catacombs, nor those of her emperors in their magnificent tombs; they have been washed into the sea, and rolled towards the fires of Vesuvius and Ætna. As to us, nations of modern date, the ocean has likewise received many a melancholy contribution of the bones of those who have fallen in naval engagements. What masses of artillery and metallic treasures have

sunk in the course of ages to the bottom of the deep. Oh! how much more useful would be the diver's bell than the balloon of the aëronaut! Boastful monuments of our glory are erected in our public squares, and described in the page of partial history; but the real monuments of our enthusiasm and of our sufferings are permanently deposited in the bottom of the deep. Yet a day will arrive when, after the changes produced by the lapse of ages, they will come forth to view, and be displayed to the eyes of our wondering posterity, in the same way as the remnants of elephants, of crocodiles, and of the mammoth, have been exhibited to our own.

It is remarkable that shell-fish, and in general fishes of brilliant colour, are most frequently found near the sea-side; while those of a darker hue reside in the bosom of the deep. There seems little doubt that bright marble, whether of red, purple, blue, yellow, or green, has been formed, in progress of time, by the relics of the former, and dark-coloured marble by those of the latter. From this a notion might arise that the receptacles of the former pointed to spots which were anciently the borders of seas, while those of the latter were indicative of its depths. This speculation might be assisted by an examination of the different degrees of hardness of marble,

on the principle that, the greater the weight of superincumbent water, the stronger the compression on the compact material. In support of this notion, I may refer to two small pieces of marble of the genus Lumachellis, or conchytes, of the size of little more than half a crown, which are to be seen in the Museum of Natural History at Paris. They shine with the brightest colours of the morning, in consequence of having at their surface some fragments of muscles of Magellan; they are moreover very tender, and were probably generated near the surface of the water, that being the abode of muscles. I am not apprized of the place where they were found; but their splendour is so bright, that our unfortunate queen, Marie Antoinette, to whom they belonged, intended that they should be made into a pair of bracelets.

Salt-water is about a thirty-second heavier than fresh-water, on account of its saline contents. As calcareous stones have evidently been formed in the sea, it would be curious to inquire whether these stones have any intrinsic saltness, since, if that is not the case, we might conclude that the sea was not originally salt, but had derived that quality from contact with certain portions of the earth. If, on the other hand, calcareous stone be found to contain inherent saltness, the pre-

sumption is that the nitre sometimes found on their surface is an efflorescence or decomposition of sea-salt. Be this as it may, bodies are found to swim with greater ease on salt-water, and to immerse a thirty-second less of their weight than in fresh-water. This difference may serve occasionally to account for the capture of whales and other large fish, which, on coming to the mouths of rivers in quest of food, are apt to run aground and stick fast in the sand.

The centre of the earth attracts to it all the bodies at its circumference, as we shall see in the following paragraph. It is a universal loadstone with poles of a particular kind. Water owes to this attractive power its level and its circulation. There are two kinds of level: the apparent, which is in a straight line; and the true level, which forms a spherical curve: the instrument known by the name of level gives the apparent one only, and can be applicable merely to short distances, its visual ray being but a tangent of the globe. The true level, on the other hand, is that by which water puts itself in equilibrium, by its tendency towards the centre of the earth, and accumulates around that centre in a spherical form. This is so perceptible at sea as to hide from observation, at the distance of only fifteen English miles, a ship of war of the first rate,

with a mast of 180 feet in height; the weather-flags are perceptible at a distance of twelve miles; the top-gallant masts at ten miles; the fore-mast at seven or eight miles; the lower masts at five miles; and finally, the hull at three miles.

Water attracted towards the centre of the earth runs from high to low situations, as is evident in the case of brooks, streams, and rivers. Hence the general conclusion that, whenever water is in a running state, it is in a progress of descent from a higher to a lower position. The ocean having a general current from north to south, both at the spring and autumnal equinox, the conclusion is that our frozen zone lies higher than the torrid zone. As this current lasts during the six months of our spring and summer, it evidently owes its origin and its continuance to the melting of the polar ice, which extends over many thousand miles, and the atmosphere of which is then warmed by the sun. The following six months produce from similar reasons a current in the ocean in a contrary direction; and we are justified in concluding that the poles of the earth receive an augmentation, if not in themselves, at least in the mass of ice which is thrown over them.

This general current of the ocean is productive

commonly of two lateral currents in a different direction. These originate in the removal of the mass of water in the middle of the ocean, which forces by its progress the lateral waters to move forward and replace it. This is exemplified in the case of the launch of a ship, the water being made at first to rush forward, and afterwards to flow back. A similar reflux may be perceived on the sides of the streams of a rivulet when flowing into a basin, or when passing from a broad to a narrow space. The reflux is necessarily greater at sea, inasmuch as the salt-water in the middle is heavier than the water towards the shores, the latter containing a larger proportion of fresh-water. It is to these counter-currents that we owe the flux and reflux of the tide, which takes place, as is well known, nearly twice in the course of twenty-four hours.

Aquatic Harmonies of the Earth.

> Amans, heureux amans, voulez-vous voyager?
> Que ce soit aux rives prochaines;
> Soyez-vous l'un à l'autre un monde toujours beau,
> Toujours divers, toujours nouveau.
>
> LA FONTAINE, *Fable des Deux Pigeons.*

A RIVULET, small and simple as it is, may be considered an image of the ocean. It has its pole and its source in a rock which attracts vapours; its current between hills, as the sea has its currents between opposite tracks of land; and it has, as we have just remarked, its lateral counter-currents, when it passes from a wider to a narrower space. It forms, in the progress of its course, promontories, shoals, and islands on a small scale. It pleases our sight by its reverberations of light; our touch by its freshness; our sense of hearing by its murmurs. Its circulation seems even to have some analogy with that of our blood, having the effect of regulating and calming it; while in the way of quenching our thirst, it does more than can be done by the saline contents of the sea. Such is a rivulet, even when running among barren rocks; but when it traverses meadows and forests, a thousand flowers blossom on its banks; birds people

the trees which overshadow it, and make the echoes resound with their songs. The shepherdess leads her flocks to pasture by its side, and sees her own image reflected in the stream, or reads on the adjacent trunks the votive offerings of her admirer.

Leaving these descriptions until we come to treat of mental affections and conjugal harmonies, we shall at present confine ourselves to the properties of mere matter. The earth has various hydraulic attractions: first to her centre, which places around her all the seas on a level; next to the summits of her mountains, which attract the clouds; and finally to her poles, which fix atmospheric vapours in ice. All these exterior attractions appear ramifications of her central attraction; and were they not to exist, we should see vapours swimming through the atmosphere without coming to any determinate point; neither the well, the rivulet, nor the sea, would be provided with permanent sources of supply.

It seems probable that all the substances found in the bosom of the earth, with the exception perhaps of granite, have been deposited there by water. Our quarries are formed of vast beds of shells, of free-stone, of lime-stone, of marble, of flints, or of sand, arranged generally in horizontal layers, and filled with marine substances,

of which indeed they are frequently mere mixtures or fragments. Even the volcanic lava found at the summit of the mountains of Auvergne, of Vesuvius, Ætna, and Hecla; the basaltic ranges which are nothing but crystallized lava, were originally the products of the waters of the sea, since it is to the bitumen with which they are stored, and its fermentations, that volcanoes owe their heat and their support. I have already observed, in the "Studies of Nature," that almost all volcanoes are in the neighbourhood of the sea, or of large lakes.

What appears to me most extraordinary in the dissemination of all these fossils, made, as apparently it has been, by chance, is our finding in the heart of the Continent of Europe, and particularly in its most northern part, remains of vegetables and animals belonging to the torrid zone. There is in the quarries of the Touraine, a prodigious quantity of cornua ammonis, a kind of shell so called from bearing a resemblance to the ram's horns, in the shape of which the ancients represented Jupiter Ammon. They are turned in volutes, and vary in size from the diameter of a pea to that of a small carriage-wheel. Nothing similar has hitherto been found in a living state in any part of the sea, though there may be something of this description in the

Southern Ocean, which as yet has been so imperfectly surveyed. The Straits of Magellan, situated at the entrance of that ocean, have afforded us specimens of a small shell-fish in life, which till then was known only as a fossil in the vineyards of the Lyonnois, and passed by the familiar name of the cock and hen, from its resemblance to these animals. The discovery of these living specimens took place in 1772, by Bougainville in his voyage round the world. I have seen in the cliffs of Normandy near Dieppe, the *tridacna gigas*, a large shell, weighing several hundred weight, which may be said to pave the Archipelago of the Indian Ocean. There is somewhere in Holland an extensive range of brown earth, light and fine, which the inhabitants are said to mix with their tobacco, and which is nothing else than the remains of palm-trees and plants, the leaves and stalks of which may yet be traced. At Paris, in the Museum of Natural History, there is a block of stone found in the quarries of Maestricht, on which are incrusted the two jaw-bones of a crocodile, and some sea-urchins. The adjacent materials have been scraped away, so as to give them the appearance of a bas-relief. A similar process, somewhat more skilfully applied, might enable us to detach from several of our marbles, the

madrepores blended with them, the branches of which are still visible on our tables, and look like ears of corn. The banks of the river Irtis in Siberia are found to cover the bones and teeth of the elephant and of the hippopotamus, at a height of eighty feet. Mines of gold are wrought in that quarter, and at the time I was at Petersburgh some Russian travellers found there a transparent stone, sparkling with gold, of the size of an egg, which the Empress forthwith claimed, under the impression of its being a yellow diamond; but it proved, I believe, to be only a topaz, or, according to others, a piece of coloured quartz. Be this as it may, the mines of gold and topazes found at the present day in Bohemia and in Saxony, bear all the marks of originating in the torrid zone. It is highly probable that we might find in the fossils of the torrid zone the remains of vegetables and animals of the temperate and frozen zones, in the same way as those of the torrid are found in our latitudes.

Not only do the substances in the interior of the earth prove that they have been formed and deposited by water, but the outward part of the earth bears the mark of a similar origin. The valleys which furrow its surface have corresponding angles at their respective extremities, all indica-

ting the work of rivers which have held their winding course along the middle of these tracks. The hills bordering the valleys have generally been excavated by the continued running of water, while their tops appear to have been rounded, and their slopes shaped, by a long continuance of rain. These observations are applicable to the appearance of the earth in every situation, from the highest part of a continent to the margin of the ocean.

It appears to me evident that the sea is gradually lessening its compass, and retiring in many parts from the land. When in the Isle of France I saw large banks of madrepores, which can be generated only at sea, but which were here lying dry on the ground at the distance of two hundred feet from the water. Similar substances are found in the wells dug in that island, and several of the ridges of the interior bear evident marks of having received their abrupt form from the action of the waves. The high sandy strand of the Cape of Good Hope, as well as of the Ascension Island, where the tortoises hatch their eggs in safety; the cliffs of the coast of Upper Normandy, formerly demolished by the sea, but now situated at a distance from its rage; the vast layers of pebbles which have fallen from these cliffs, and on which the town of Havre de Grace is built;

the situation of the old town of Honfleur, erected on a similar foundation, at the mouth of the Seine, in the time of Edward III., who embarked there with an English fleet on a spot which a shallop could not reach in the present day;—are all circumstances tending to prove more or less that the ocean has withdrawn from its shores. Such an opinion, however, ought not to rest upon my detached evidence, but should have the support of facts of a comprehensive character. These I think we may find in history, and in the general appearance of the earth. Scandinavia, that extensive portion of the north of Europe, is understood to have been formerly separated from the continent by an arm of the sea extending from the White Sea to the Baltic; the Gulf of Bothnia is the remaining part of this strait, the remembrance of which is preserved in the ancient Swedish poems. Some persons are disposed to find a confirmation of this in Tacitus, who mentions a *mare pigrum ac immotum*, which froze annually, and which he considered as a kind of girdle of the globe, joined to the Hyperborean ocean. Nay, it is imagined that something of the kind could be traced in the time of the well-known geographer Mela, who says that the space between the islands in front of the territory of the Sarmatæ, that is, in the Gulf of Bothnia, is

sometimes dry and sometimes covered by the flux and reflux of the sea. Pennant, on quoting these passages, concludes that there was in those days of antiquity a strong tide in the upper part of the Baltic. Finally this sea, which has long been mediterranean, is said to decrease at the rate of forty or fifty inches every century, if we may trust to the observations of several naturalists. The Gulf of Bothnia is said to have withdrawn from the land half a mile in the course of forty-five years in the neighourhood of Pithea, and no less than a mile in the course of twenty-eight years in the neighbourhood of Luhlea. The sandy tracts of the west of Africa, and the vast deserts of Zaara adjacent to them; those of the interior of Asia, which still contain lakes of salt water; those of New Holland with their shoals, which embarrass the navigation at the distance of more than seventy miles from land; a part of the continent of South America, which extends in vast levels from the river Plate to the foot of the Cordilleras; as well as the calcareous mountains scattered throughout Europe—all tend to show that the greatest part of the globe owes its origin to the operation of water, and has risen progressively above the level of the latter.

A phenomenon of more frequent occurrence, and more remarkable than the deposit of marine

substances in the heart of continents, is the quantity of fragments of stones scattered along the surface of the earth in all directions. Naturalists appear to me to have as yet paid very little attention to the explanation of the fracture of stones and rocks, whatever may have been their progress in accounting for their formation. Yet the existence of a particle of sand appears to me more difficult of solution than the formation of a mountain; the latter being evidently an accumulation of particles, while our doubts apply to the creation of the particle itself. If it be said that the smaller substances are merely fragments of the larger, we may be permitted to ask in what manner the separation has taken place, and why in such prodigious quantities? This leads me to the exposition of an hypothesis which, I flatter myself, will afford a satisfactory explanation of all these phenomena, and which is the more entitled to attention from its being a result of the ordinary harmonies of nature.

I begin by laying down as a principle that all things in the universe have been at one time in a state of infancy; some taking their origin from a fluid; others, like vegetables, from a seed, and animals from an egg or amnios. They pass subsequently from one kind of harmony to another; from that of the sun which has engendered them

to what I have termed the spherical harmony which brings them to their definitive stations in the globe. An oak, for example, originates in an acorn, and after coming out of its covering, raises a stalk, becomes covered with leaves, flowers, and fresh acorns; these being disseminated, in progress of time, form, first a grove, next a wood, and eventually a forest, which in the long run may be extended almost indefinitely along the surface of the globe. Other kinds of vegetables pass through a similar process, and compose in a collective body that vegetable kingdom which is spread over the circumference of the earth. Of the whole vegetable mass, there is not one which has not owed its increase in a considerable degree to fluids; particularly to the water and vapours of the atmosphere. Far from exhausting the soil on which it stands, it augments it annually by a deposit from it. Animals, in the same way, derive part of their size from fluids contained in vegetables, and pass, on the whole, through a process a good deal similar.

After laying down these preliminary points, I proceed to suppose that the earth was at first covered with water, and had only the primitive lineaments of its organization; I mean the tops of the high mountains of granite, which must have been apparent on its surface, and probably con-

stituted, by their attraction and their electricity, the primary parts of continents and islands. The globe may be said to have a resemblance to an egg, which contains the head, the heart, the organs, and the nerves of a bird, all of which are destined to receive a subsequent growth by the combination of heat with its fluid after a certain number of revolutions round the sun. The comparison of the globe to an egg, whimsical as it seems, may be traced to very high antiquity; among eastern nations it is in a manner the commencement of their system of religion and of physics. And, in general, it may be remarked of ancient fables, that the truth in them is concealed only in as far as that which was truth in those days is ascertained to be fiction in ours.

Supposing then that the globe in its commencement allowed only primitive mountains to appear above the water, the probability is that the latter formed two great chains; that of the Cordilleras extending in America from north to south; the other, that which crosses Africa and Asia from west to east. These two chains are nearly equal in length, and in following them it would be wrong to be guided by the present situation of our pole. We ought rather to commence the first chain at the Straits of Magellan, and terminate it in the southern extremity of Norway;

while for the second we might take our departure from the Peak of Teneriffe, or the Atlas ridge, and pass by the Mountains of the Moon in Africa, as well as by those of Imaus, Caucasus, and Thibet in Asia, until we are arrive at the extremity of that continent in the direction of Kamtschatka. In each case we find a nearly continuous chain, separated sometimes by arms of the sea or by valleys, but preserving a great height throughout. Each of them embraces nearly half the circumference of the globe, or 180 degrees, the first of latitude, the second of longitude. They lie in an oblique direction toward each other; so that the chain in the old world corresponds, by its western extremity, to the middle of that in the new world, while its eastern extremity appears to approach to the other towards the northern straits separating America from Asia. We shall find it practicable to trace on the map these two primitive chains by following the sources of the rivers which flow from them to right and left.

These chains of mountains correspond with two oceans extended in similar directions; the American chain to the Atlantic Ocean, the length of which is from north to south; the African and Asiatic chain to the Southern Ocean, of which the greatest extent is from west to east. They receive from these oceans watery stores to

feed the rivers, which are poured subsequently into their bosoms, after having traversed extensive ranges of continent.

Every primitive mountain probably bore from the beginning the species of vegetables and animals which belonged to its latitude, and which would naturally extend themselves as the progressive removal of the water gave an augmented surface to the land. The aquatic globe, in the state which we have supposed, probably turned first towards the sun, which would attract its heaviest part, namely, that where the two great chains of mountains approach each other. The consequence would be that its equator would pass by one of its present meridians, and its torrid zone across the two frozen zones. Pursuing the same supposition, the globe would have its two poles placed one towards the Isthmus of Panama, the other towards the straits of Java, so that its two frozen zones must then have formed a part of our torrid zone. There would be in this position no particular difficulty in the earth revolving on itself by the mere action of the sun on the waters of its equator; for the heat of the sun, rendering the waters to the east lighter by evaporation, forced the western part of the globe to approximate to him, so that the whole globe successively revolved on its axis.

Mairan, the celebrated mathematician, has demonstrated in an able memoir, that the mere evaporation of the waters of the ocean was sufficient to produce the rotation of the earth. The first movement produced night and day.

The poles of the earth, in this position, seeing the sun only on the horizon, become, we may suppose, covered with ice; and the one which we have imagined to be placed in the Straits of Java, having a greater proportion of sea around it, would be covered with more ice than its antipode at the Isthmus of Panama. In such a situation it was naturally inclined towards the sun, and a part of it would be melted, until the opposite pole, having become heavier by the augmentation of its ice, approximated to the sun in its turn. From such alterations in the movement of the two poles, proceed those changes of weather which give us variety of season.

As the poles would lose in summer only a part of the ice which they had got in winter, the result would be their becoming in the long run heavier than the chains of primitive mountains which served as their counterpoise in the torrid zone; and as I have supposed the pole near the Isthmus of Panama to have a larger proportion of mountains, and to receive a progressive increase of weight by the accumulation of ice, the

consequence would be that it would become the heavier, and the earth would gradually lose its first equilibrium. This pole, which I shall call western with reference to our position, may then be supposed to have insensibly passed along the segment of the circumference extending between it and the north pole, where it appears at present to be fixed, and to have determined, in the course of the year, the inclination of our hemisphere towards the sun seven days more than the other hemisphere, which, by way of counterpoise, is loaded with a much greater quantity of ice. From this progressive augmentation of weight at one pole, there resulted a third movement of the earth, so as to produce a slight variation in the inclination of its axis to that of the ecliptic. This hypothesis is suggested to me in consequence of the Isthmus of Panama and the Straits of Java (which I have supposed to be the two primitive poles) being at the distance of 180 degrees from each other, the distance existing between our present poles; from the one being, like our north pole, in the middle of a continent, and the other in the middle of a sea; from the two chains of primitive mountains being, in regard to them, in inverse, but similar directions, so that the consequence was the same equilibrium for their corresponding oceans. My

idea is farther supported by the circumstance of the lands and rocks environing the situations now mentioned being intersected and broken like those of our frozen zones, an effect not to be accounted for by any existing currents in these seas, nor by the temperature of the atmosphere; and I farther conclude that they must at one time have been in the midst of the frozen zones, since Europe, distant ninety degrees from either, seems to have been, at some period or other in the history of the world, in the midst of the torrid zone, as is proved by its fossils.

Let us now attend to the consequences that would result from such a disposition of the globe. At the commencement it is evident that the ice which would fix itself at the poles must have proceeded originally from the bosom of the ocean, and have diminished its bulk; hence an extension of the proportion in land, whether in the shape of islands or mainland. While a portion of the watery world, after undergoing the process of evaporation, was fixed in ice on the poles, another portion became changed towards the equator into the substance of the vegetables and animals which increased as the land extended. Genera of immense extent, and of an almost endless variety of species, such as shells and madrepores, proceeded from the bottom of

the deep, and formed shoals, promontories, and islands, the surface of which is covered at the present day with cocoa-trees in the midst of the Southern Ocean. So numerous and so extensive are the genera of this description, that the soil of Europe appears in a former age to have been in a manner formed out of their relics. They extract a solid substance from water, in the same way as vegetable products from the vapours of the air, and terrestrial animals from the juice of vegetables. We may perceive, without the aid of a magnifying glass, a periodical augmentation of the bottom of rivers by a succession of annual deposits. Water seems to be, like the sap of trees, a kind of fluid earth, and the blood of animals may be called a kind of liquid flesh.

I am inclined to account for the greater extent of the ocean in comparison with the land, by the necessity of seeking in water a supply for all these transmutations. Reduced as I imagine the ocean to be, it is still about twice the extent of the terrestrial part of the globe. The Atlantic Sea supplies, by its evaporations, to the rivers of Africa and America, a greater stock of water than they require, while the Pacific and Southern Oceans, far more vast and deep, water only a few islands by their vapours; but they feed the

ice of the South pole, which in winter is of several thousand miles in circumference.

I might add a number of other circumstances in support of my hypothesis. The remains of vegetable products, of shells and of animals belonging to a tropical climate, found in such abundance in the quarries of Europe and Siberia, argue that these countries must formerly have had a climate similar to that which is found at present in the torrid zone only. It seems impossible that any currents could have brought quantities of the *tridacna gigas*, of the weight of several hundred pounds, to the cliffs of Normandy, or bones of elephants to the banks of the Irtis. It deserves to be remarked that the extensive banks of shell-fish, found in the interior of land, are not without arrangement, as would undoubtedly have been the case had they been thrown thither by any convulsion of the ocean; they are deposited in layers extending lengthwise, as if the spot where they are found had been that of their generation and growth. We find them of all sizes, and classed, if I may say so, by families. It is probable that Nature, still more fertile in the bosom of the sea than on the surface of land, makes arrangements for putting a stop to that progress of animal population which would otherwise fill even the ocean in the course

of ages. The female of the cod-fish is known to contain millions of eggs; so that, to prevent the indefinite multiplication that would take place, Nature has appointed fish, birds, and men to prey upon them. But what would be the consequence were each of these species covered by shell work? The produce of our fisheries would soon be sufficient to fill our harbours. Now it seems likely that Nature employs, for the destruction of entire generations of marine shell-fish, means of the same kind as those which are brought into action against insects. At the autumnal equinox a north wind is sufficient to destroy legions of flies and butterflies; while the high tides, mixed as they are with muddy and sandy particles, may, for aught we know, destroy and bury banks of shell-fish. It is not improbable that such is the intention of those periodical and violent hurricanes between the tropics, where shell-fish and madrepores generate so rapidly that, if a vessel get aground and stick fast at the mouth of a harbour, their accumulation is such as to fix her to the spot like a shoal, in the course of a twelvemonth. This I have myself witnessed at the Isle of France; where the hulls of four vessels, neglected and allowed to rot in the harbour, had been made by accumulated madrepores to look like so many rocks, and could

not be disengaged from their position till cables and machines were brought from Brest at a great expense. The shelves which surround that island like a girdle are formed altogether by sea insects, and there is in fact hardly any means of approaching the coast except at the mouth of the rivers; a proof that the deposit made by a stream of fresh water, or perhaps the mere action of its current, is sufficient to stop the labours of these tenants of the deep.

I conclude therefore that the different layers of shells in our quarries are to be traced to similar causes. As to the elephants' skeletons in Siberia, it is singular that they are found collected to the number sometimes of fifty, at a depth of more than eighty feet on the borders of the Irtis. They are discovered by the ravages made in the banks of that stream on the occurrence of mighty floods. The circumstance of their lying in quantities together may be ascribed to the well-known disposition of those social animals to live and die along with others of their species. When they find their life drawing to a close, they are said to seek in the neighbourhood of water a solitary spot where they may expire under the shade of trees. This custom is well known to orientalists; for in the Arabian Tales, a work where the habits of animals are equally well

described as the customs of men, we are told of a huntsman who made a sudden fortune by finding a surprising quantity of ivory in a spot frequented, in this manner, by elephants, and converted into a kind of cemetery. The bones and teeth of those which are found in a fossil state on the banks of the Irtis are considerably thicker than those which the chase supplies to the African hunter; a proof that the Siberian elephants died at an age in which they had attained their full growth. The layers of earth with which they are covered proceed, no doubt, from alluvial deposits made by the Irtis.

My theory in regard to the original position of the poles of the earth would receive fresh support, could we find, at the Isthmus of Panama or the Straits of Java, bones of such animals as the rein-deer, the sea-horse, or the white bear, along with the remains of trees of a northern clime, such as firs. But the selfish men, who penetrated into the depth of the earth to gratify their avarice, did not take the pains to look even at its surface for those things which might have enlightened their minds; so that the natural history of these rich provinces is in a manner entirely unknown. The jealous avarice of the Europeans prohibits the exportation of the seeds of the valuable vegetable products of these countries,

of their cloves, their nutmegs, their vanilla, and does not even permit a traveller to penetrate into the interior. We are thus obliged to confine ourselves to the superficial accounts which have as yet been given; yet these even seem to supply some reasons for believing that these lands, so much favoured at present in point of climate, were formerly under a frozen zone.

The rocks of the torrid zone are broken in every sense of the word. Their fragments are not spread along their bases, but are scattered at a great distance over the surface of the land, and even a great way into the interior. We cannot, with any confidence, ascribe such effects to earthquakes, volcanoes, or the operation of heat. Earthquakes may overthrow mountains, and give elevation to a plain; but they cannot cleave a solid rock, burst a flint, or produce those immense beds of sand and gravel which are formed by the fragments of these substances. A volcano may melt or calcine a stone, but it very seldom breaks it; and when lava bursts, it is by the sudden operation of cold, or in the same way as melted glass plunged into a fluid on being taken out of a furnace. The sun's heat, however great its intensity, has never been known to burst a stone. The Isle of France, where, according to all probability, there never was either a volcano, (since

there is no appearance of lava,) nor an earthquake, is filled throughout with rocks which prevent the plough from being used in agricultural labours. The same I have understood to be the case in our Leeward Islands, and in most of the islands of the torrid zone.

Before attempting to ascertain the manner in which stones are cleft, we ought, in my opinion, to understand the manner in which they are formed. The fashionable mode of explaining at the present day the junction of their parts is by mutual attraction, but this principle, too much generalized as it is, does not afford a satisfactory solution. Were it the case that a stone attracted other particles of stone, it would, on being put on kindred sand, be covered over in the same way as a loadstone becomes covered with the iron filings on which it is placed. This, it is well known, does not take place; and my opinion is that the fracture of stones was originally produced by the alternate action of heat and cold at the time when, as my hypothesis implies, they were under an icy atmosphere. In such a situation they would undergo what takes place at present in our winters, in which frost and thaw have the effect of breaking them, and even of reducing the ground into petty fragments. Captain Cook represents the most remote isles of the

Southern Ocean as covered with fragments of rocks to such a degree that one can hardly set a foot on their hills, or attempt to walk up their sides, without running the greatest hazards. Martenz exhibits a similar picture of the rocks of Spitzbergen, describing them as masses of granite in a state of dissolution. "The stone of these rocks," he says, "has veins of different colours like marble, red, white, and yellow. This stone perspires, if I may use the expression, upon a change of weather, and gives its colour to the adjacent snow, which is apt likewise to become red by the rain which occasionally runs down the side of the rocks. At the bottom of the mountains, where there are no accumulations of snow, we meet with blocks of rock which have fallen above each other, and between which there are clefts, so that it is a matter of great difficulty to walk over them. These stones, or rather fragments of rocks, are of all sizes, and are mixed together so as to resemble a heap of ruins; they are of a grey colour, with black veins, and shine like silver ore. The summits of these mountains, seen from below, appear to consist of earth, but on getting up to them we discover nothing but rocks, as at their base; which is farther proved by the frequent fall of fragments and blocks. When a stone is thrown from the top of these

mountains, the noise of the fall makes the valleys resound like thunder. Most of the mountains are so high that, whenever the weather is not clear, they appear half covered with the clouds, and some of them look as if they were on the eve of tumbling. The height of a ship's main-mast is not to be put in comparison with that even of the smallest of these hills. A large fragment of one of them was detached with a dreadful noise, one day that the sun shone in full splendour, and that the air was perfectly calm."

Travellers in Switzerland give nearly the same account of the glaciers and rocks of granite in that country. It must, however, be confessed that the navigators who have proceeded in the direction of the North Pole have, in consequence of the simplicity of their narratives, given more instructive data for the theory of the earth than our land travellers; they may be said to have visited the trunk of the tree, while the others have seen only its branches. As for me, without having proceeded, like Martenz, to the eighty-first degree of north latitude, I have witnessed, in the sixty-first, similar effects of frost and thaw on the rocks of Finland. That country is, in a manner, paved with small hills of granite, rounded at the top like a leather cap, and furrowed with chinks through which the water oozes in all

directions; so that one is often apt to slide in endeavouring to gain the top. The sides of these hills are often exfoliated, and burst by the effect of the frost of winter, so that the adjacent vallies are filled with their fragments; yet moss, mushrooms, and firs, grow there in abundance. These hills are entirely different from those of our part of Europe; having neither salient nor re-entering angles to correspond, and being in general insulated, of an oval form, and surrounded in all directions by a small valley. To compare great things with small, they are not unlike a stone set in a collet. I collected several pieces of them which were of a red and white colour with a slight degree of transparency. On rubbing them against each other at night, I was greatly surprised to discover a phosphoric light in their inside, and to find that they emitted a sulphureous smell. I had taken them at first, like honest Martenz, for pieces of marble, but soon learned that they were of granite. It was one of these blocks detached by a natural fall, that Catherine II. got transported all the way from Finland to Petersburgh to form the base of a statue for Peter the Great; as if that city were not itself a much more illustrious monument to its founder than a fragment of a rock conveyed by the labour of his people. Finland is so much covered with

these broken rocks, that ancient geographers gave it the name of *lapidosa*. The cause of such repeated fractures is to be sought only in the alternate operation of heat and cold. Something of the same kind may be seen in our temperate climates, not only on the trees which frost and thaw affect so visibly, but on the stone of our buildings, and even on granite. We have at Paris, at the gate of an hotel opposite the Capuchins, Rue St. Honoré, two pillars of granite, the tops of which, thirty years ago, were ornamented with polish and moulding, but are now exfoliated by the operation of the frost in winter.

The conclusion from all this is that the fragments which at present cover a part even of our temperate zones were formerly under an icy zone. In support of this it may be observed that the polar ice is in a state of progressive augmentation, and the torrid zone in a correspondent state of diminution. The latter, in the time of Pithéas, is understood to have extended forty-seven degrees and forty minutes, while at present its extent is not beyond forty-seven degrees. If there be any accuracy in these comparative statements, the result is that the angle formed by the axis of the equator and by that of the ecliptic, which at present is of nearly twenty-three degrees and a half, is less by twenty minutes

than it was two thousand years ago. The inference from such data would be that, in the course of so long a period as 141,000 years, our equator and our ecliptic will coincide, and will have the same poles; that is, that the days would be equal to the nights. Finally, an alteration in the inclination of these two axes is said to be observed in some of the planets, a circumstance which, along with other reasons already stated, tends to confirm the notion of these planets having seas contributing to their rotatory and periodical motion.

The two icy continents, which cover the poles of the world at the extremities of its axis, may be compared to two weights at the extremities of a lever in equilibrium. As these weights are in a state of progressive augmentation, they produce vibrations, which however diminish until the whole rest in a perfect equilibrium. From this it is evident that the greatest part of the earth would be uninhabitable, as the torrid zone would be over-heated by the constant operation of the sun, while the frozen zones would never experience a melting power from never having the sun on their horizon. Nature therefore has done nothing in vain, and even makes progressive improvements in her works; she seems to me, moreover, to increase from time to time the pro-

portion of land on the earth. I am inclined therefore to believe that, whenever the poles of the ecliptic become the same with those of the equator, the poles of the earth are likely to change in consequence of the weight of that hemisphere where the greatest accumulation has taken place; for a main land must be in a state of augmentation in consequence of the course of vegetation, which goes on converting atmospheric water into vegetable substances; while in the southern hemisphere, composed of a vast track of water, the weight of these waters, fixed as they are in ice, must be considered as having arrived at its maximum.

My theory points therefore to the probability of an eventual, though a very remote revolution in the position of the globe, and to the idea of the poles changing along with the centre of gravity of the earth, or the latter losing its equilibrium. The equator, being gradually lightened, will become insensibly the meridian; and the meridian, from increased weight, the equator. Among the first features of such a change, would be a partial deluge consequent on the melting of the masses of ice accumulated at the poles. The history of almost all nations concurs in recording a calamity of this nature, which, according to my theory, must have taken place at the time when

the earth had for poles the corresponding points at the Isthmus of Panama and the Straits of Java. The result seems to have been that the mass of water, on fixing itself in the shape of ice at the north and south continents, retired from a portion of the land which it formerly covered, and left it to be possessed by the vegetable kingdom. The harmonies of the earth were not changed but occupied different situations, the east becoming north, and the north becoming east. Those who put faith in ancient legends may cite in support of my theory the tradition of the Egyptian priests, that the sun formerly rose in the west. They who pursue the speculation farther by calculating that it was then that half the quantity of the habitable earth was relieved from the pressure of water; that Europe became dry and spread itself along its ferruginous soil; that the sable Africa appeared with its yellow sand surrounded with palm trees; that the innocent America arose out of the bosom of marshes, with mines of silver in the midst of her plantains and sugar canes; while New Holland, covered with vast tracks of sand, raised her head like a child from the cradle. A poet would represent these different parts of the world coming forth like daughters of the deep, adorned with maternal gifts, and destined one day to aid each

other in interchanging the blessings proceeding from the sun, the common father of their vegetable treasures.

This supposition of a progressive increase of the continent implies a great revolution in regard to the borders of the sea. The portion of water deposited under the surface of the earth forms, as we have already said, a subterranean store with which fossil sands are impregnated even at a great depth. This is shown in the case of wells, which are one of the chief methods of rendering the earth habitable throughout, by affording us reservoirs of fresh water under almost any situation. The water suspended in the atmosphere, or aërial ocean, as it has been termed, answers the purpose of decomposing light into colours, and of affording fertilizing showers; the fluid expanse appears formerly to have formed mountains and continents; while the icy sea operates to refresh the torrid zone; and the waters under the surface of the earth conduce to the formation of minerals. These subterranean waters, tranquil as they seem, participate in the great agitations of the works of nature, and are conducive to the formation of volcanoes and earthquakes. These dreadful phenomena are formed in part by the dissolution of nitre, bitumen, and mineral sulphur; of vegetable and animal products hurried by

rivers into the bosom of the ocean, and deposited in certain parts of its borders, where they undergo fermentation; and also by the dilatation of the subterranean waters which lie in the adjacency of these deposits. When the inflammable materials which impregnate a portion of the borders of the sea experience only a simple fermentation, and when, after a long drought, falls of rain suddenly close up the surface of the earth and prevent the passage of their exhalations, it is then that they produce those dreadful shocks which are felt at so great a distance from the focus of the movement. These shocks have long been known by the emphatic name of earthquakes. I never had the misfortune to witness one, but I am familiar with the descriptions of them; and of all that I have read, that which most strongly affected me was the one seen and described by Kircher. He was sailing in a felucca along the coast of Italy, when a sudden and prodigious swell of the waves obliged him to disembark. Scarcely had he and his companions set foot on land, when the shaking of the ground around them showed that it was an earthquake. On this they immediately re-embarked, and were carried about a league farther along the surface of the water; but the sea becoming more and more agitated, they were a second time obliged to seek shelter on the coast.

They landed near a town with which they were acquainted, and which was called, I believe, St. Euphemia, situated about two miles from the sea-side at the foot of a mountain. Having drawn their felucca upon the sand, they set out towards the city, and crossed a wood lying between it and the shore. After passing through the wood they could discern no habitation, but they perceived a young man sitting on the fallen trunk of a tree, with a mournful look and with eyes fixed on the ground. They asked him repeatedly where the town stood; he gave them no answer, but rose up, and, pointing with his finger to an extensive lake, ran towards the forest and disappeared. This lake, which none of them had seen before, had swallowed up the town and all its inhabitants with the exception of this solitary youth.

This and other occurrences of the same kind prove that subterranean water is one of the principal agents in producing earthquakes, the effect of which, almost always, is to throw a quantity of water from the bosom of the earth. This was experienced on the 28th of October, 1746, at Callao and at Lima, two towns of Peru, which are only two leagues distant from each other. The earth became agitated, and moved about as if borne up by a fluid. This convulsion had at

first the effect of repelling the water of the sea to the distance of a league; but on its return it submerged the town of Callao with all its inhabitants, and even spread to a great distance up the country. Lima escaped destruction, but experienced shocks which overthrew most of its edifices, though of stone, and caused the death of many persons within their walls. Several lakes were at that time formed in different parts of the country. Similar effects took place at Jamaica on the 7th of June, 1692, and at Lisbon in 1755. Since the earthquake at Jamaica, the water is considered to stand higher in the wells, and the ropes used for drawing it are said to be shorter by two or three feet than before. Accordingly several philosophers of antiquity predicted earthquakes from the occurrence of any sudden change in the state of the wells.

It is then apparent that the waters under the surface of the earth co-operate with those of the sea in causing these terrible phænomena. When the materials which produce them are inflamed, the earth opens, and a focus is formed which is kept incessantly burning by fresh materials. The stones, the vitrified earth, and the *scoriæ* vomited from it, form around it, in the course of ages, a mountain, the summit of which rises eventually to a great height. It may even be supposed that

Nature prepared beforehand these volcanoes with their subterraneous furnaces in the highest chains of mountains, and on the borders of the sea, for the sake of purifying them. At all events it is certain that volcanoes in activity are found only in the neighbourhood of water. The remains of those which at present are at a distance from water, and which, like those of Auvergne, are extinguished, afford the clearest proof of their having had the ocean in their neighbourhood; for we find around their bases a quantity of marine fossils. Moreover, in the eruption of volcanoes, torrents of fresh water are seen to issue from their sides, in such a quantity as to overflow, and sometimes even to drown, the adjacent country. Some naturalists attribute volcanoes to an assemblage of rain-water in the crater; but how is it possible that rain could fall there without undergoing a prompt evaporation, since the fire contained in it dilates the interior water, and forces it to open a passage through the sides of the mountain?

It follows then that volcanoes are formed and kept open, in a great measure, by water situated both above and below ground. Earthquakes, volcanoes, and torrents of water, are all instrumental in incessantly renovating the globe. Were the earth to remain constantly in the state in

which we see it, its mountains would progressively decline, and the ocean would be filled up with their remains. It is the ocean that has levelled the strata of the earth; it is the ocean that overturns, and that re-establishes them. Nature acts like a labourer who cultivates his ground in opposite ways; she raises what is low, and brings down what is elevated; sending to the north the fossils of the south, and to the south those of the north. She makes use of the ocean as her ploughshare, and the globe admits, in consequence of its spherical shape, of being furrowed by water in all directions. Men construct barks with a single prow to sail backward and forward on the sea; but Nature constructs barks capable of sailing in every direction in our atmosphere. The effect of a spherical form being, as I have just said, to admit of being traversed in all directions, every point of its circumference may be considered a pole, and every circle an equator. Frozen mountains are disseminated in every latitude; their summits possess the power of incessantly attracting vapours, and they have sufficient slope to enable the waters which flow from them to run into the bed of the sea at whatever distance. It is singular that lakes, situated at the bottom of frozen mountains, are frequently as deep as the summits of these mountains are

high. The Southern Ocean is supposed to have, in its profoundest part, a depth of nearly four miles, which corresponds to the height of the loftiest of the Cordilleras. If to this height you add the pyramids of ice, which at the pole may be supposed to rise to the height of four miles perpendicular, (since under the torrid zone it rises to a third of that height on the top of the Cordilleras,) you will have in all an elevation of eight miles; an elevation which, at the rate of a foot per mile, gives the ocean an ample fall to enable it to roll round the globe in a spiral direction. The fall of the Seine is by no means so great: at the bridge of Notre Dame it is computed to be only seventy feet above the level of the sea, although, including windings, it performs a subsequent course of more than seventy leagues.

The hand of Providence is to be traced in the arrangement of fossils as well as in that of vegetables and animals. Trees growing on the borders of rivers, and even on the sea-shore, are liable to be overset by currents, as takes place with willows and mangroves, the branches of which become roots, and the roots branches. These borders of the water may in like manner be rendered, in the course of ages, either basins or mountains. As a branch possesses the properties of the trunk which bears it, a mountain

may be said to have, in the some measure, the properties of a vast extent of land. Some persons are apt to account themselves unfortunate on seeing around them an immortal Nature, while we personally are in a state of daily decay. How much more unfortunate would it be that we were immortal, and that Nature should wax old and decay without the power of repair? In what manner could that perpetual life be supported by transient enjoyments? But Nature is in a state of perpetual renewal, and if we are destined to fall successively in fulfilment of her laws, it is for the purpose of extracting a better life from the relinquishment of the present. She does not delight in a monotonous routine of creation and destruction; nor is she contented to derive incessantly the same harmonies from the same objects, like a painter who should occupy himself perpetually with the same landscape, like a musician who should dwell eternally on the same tune, or like a poet of barren imagination who should incessantly repeat the same drama. Nature varies without end her scenes, her paintings, and her characters. An ingenious mechanician arranges harmonizing tubes in a frame; he composes corresponding notes by means of small pins skilfully fixed on a cylinder suspended by an axle; he turns the handle, and a melodious air is forth-

with heard; he raises the poles of the cylinder by means of notches, and new airs come forth in succession to charm the ear. Is it possible that man should have displayed more skill in a musical instrument than Nature in the formation of the globe? She has spread her different kingdoms along its surface; she makes it revolve periodically, and she sheds in succession on her products the solar harmonies of days, months, seasons, years, and ages.

God is not only infinite in duration, in power, in extent, in goodness, but he is infinite in intelligence. His works advance from perfection to perfection. The spring rising out of a rock is preferable to the vapour attracted by the rock; the rivulet running from the hill is superior to its spring. The streams which traverse valleys and plains surpass the rivulet; the majestic river, descending from lofty mountains and rolling into the sea, is more beautiful than the stream; the sea, which bathes islands and extensive countries, is far grander than any river; and finally, that ocean which surrounds the world is infinitely more magnificent than a sea. Vegetable products, for which in a great measure these harmonies were appointed, are more perfect than the winds which blow on them, than the water which bedews them, or the soil which bears them. The

animal kingdom is, in like manner, superior to the vegetable, and man to animals. Moreover, all these divisions of the kingdom of Nature are in a progressive state of amelioration. Air and water are changed into earth, as well as into vegetable and animal substances; new continents arise out of the bosom of the sea. The orchards of Asia crown the marine fossils of Europe, and extend to the shores of America, while the flocks of the ancient world are multiplied in the Savannahs of the new. But this amelioration is particularly apparent in the situation of man. There was, I believe, a time when of Europe little else was visible than the Riphæan mountains, the volcanoes of Hecla, Auvergne, Ætna, the Alps, the Pyrenees, the Appenines; a time when the fisherman cast the anchor of his bark on the glaciers of Switzerland. In progress of time the water flowed off, and Europe saw magnificent cities arise out of the bosom of obscure quarries, while stately vessels were constructed from the oaks of her forests. Her children, numerous and industrious, spread over the world, and collected an ample portion of its riches. Trees imported from the forests of the new world were made to shadow their parks, and their tables were supplied with the fruits of Asia. It may enter into the arrangements of Providence to cause at a

future period the waters of the Southern Ocean to withdraw, so as to leave behind a new continent, in which the hamlets of the poor islanders of the present day will be changed into magnificent capitals, and whence there may proceed fleets of merchantmen to trade with the old world, and anchor, to the sound of music, on our shores. The commerce of the world would then be carried on across an ocean of less extent, interspersed with fertile islands; men would share the gifts of Nature with gladness, and would put forth in concert their adorations to their common Father. A day will come, and the present generation may flatter itself with beholding its dawn, when Europeans will teach their children to substitute a disposition to mutual assistance for the fatal ambition of taking a lead among their equals; and to consider that the interest of each is identified with the interest of all.

It is from solar influence that we are to expect the amelioration of the physical world. Our atmosphere and our waters are incessantly operated on by it, and transformed into vegetable and mineral substances. The sun's rays penetrate, in the torrid zone, the bosom of the earth, and, acting in a manner invisible to human perception, produce the diamond in the mines of Golconda, the ruby in those of Pegu, the emerald in the

rocks of Peru, and the pearl in the depths of the Eastern Ocean. It is the solar ray that forms the amber on the margin of the deep, and which displays the splendour of the plumage of the feathered tribes. Improvement in the physical world is productive of correspondent improvement in our moral system. May it be the lot of our posterity to advance in the career of amelioration, until noxious passions are banished from the earth, and the human mind assimilated to those beings which now look down with compassion on our ignorance and our errors. This hope, sanguine as it may appear, is in correspondence with the arrangements of that Being for whom the sun in all his splendour forms only a medium for the transmission of blessings to feeble mortals; a spark of that glory the blaze of which extends over the universe.

Aquatic Harmonies of Vegetables.

It is not however for us, children of darkness, to speculate on objects at such a distance and of such magnificence. Let us confine our observations to our own earth, travel over its humble valleys, and follow its rivulets across meadows, orchards, and forests. We shall find there, within our reach, ample traces of an infinite Providence, and of the influence of the orb of day.

We have already described four harmonies of water with the elements, the results of which are oceans, or collections of waters, of four distinct characters: the aquatic ocean commonly so called; the frozen ocean at the poles; the aërial, or ocean of clouds; and the hidden or subterranean waters. Each of these has its harmonies, positive or negative, active or passive, of all which solar influence forms the main spring. We are now going to make an addition of a fifth to the number, an addition which, if my readers will pardon the expression, I shall call vegetable waters; by this I mean that portion of water which is circulated and modified in vegetable products, and which, by an incessant flux and reflux, transforms them into solid matter. Some idea of my meaning may be formed by fixing

the mind on the extent of our meadows and corn-fields, the produce of which fills every year our granaries and barns; on that of our orchards and vineyards, of which the fruits and liquor replenish our cellars; on that of the wood consumed in our docks and on our hearths; on the height of the forests; the thickness of their foliage, and the layers of vegetable earth formed by it after falling. All these productions are the work of that portion of the ocean which is appropriated to the vegetable kingdom. I leave to others to explain the relative proportions of these five divisions of the waters of our globe; and shall at present confine myself to the principal harmonies of the vegetable kingdom with water in its various shapes. Vegetable products harmonize by means of its roots with the water below the surface of the earth; by its bark with the frozen ocean; by its leaves with the aërial; and by its seeds with the aquatic.

The harmonies of the different powers of Nature will be found to cross each other, so that each becomes in turn circumference and centre. The disk of a daisy affords us an example of this, each of the florets of its circumference being the centre of a semicircle of florets which pass through the centre of its disk. They represent collectively the harmonies of the powers of Na-

ture spherically combined; and their central florets, surrounded at a distance by white petals, may be compared to the sun projecting his rays around the different planets. Nature is uniform in small as in great objects, and by way of enabling our feeble eye to comprehend the whole of her harmonies with the orb of day, she exhibits them to us in a grain of sand, in a drop of water, or in the bosom of a flower. Not only do the powers of Nature cross each other in their harmonies, but even in their essence or original formation. A vegetable has been called an animal turned upside down; and, in fact, if we observe minutely a tree with its branches, its flowers, and its fruits pointed towards heaven, it is by no means ridiculous to say that it has its legs aloft and its head below. It has, moreover, on the outside, several parts which in the case of the animal are carried in the inside. Its roots may be termed its entrails, its leaves its tongue; while its flowers and fruits are its offspring. Contrasts of a different kind would be found, were we to indulge in comparisons of the vegetable kingdom to the elementary powers. It is thus impracticable to describe the aquatic harmonies of vegetables in the same order as that of the four elementary oceans: viz. the icy, the aërial, the aquatic, and the subterranean. But in following

the method pointed out by the nature of vegetables, we shall pass successively from the root to the bark, the leaves, and the seeds; establishing the progressive harmonies of vegetables with water in all its situations.

To begin with the interior relations of vegetables to water, let us take, by way of specimen, a walnut, and examine it when in a state of complete maturity. It is covered with a bitter husk, which preserves it from the attack of birds, and is perhaps intended for the support of some animal unknown to us, but which may be an inhabitant of the country where the walnut-tree originates or is found to thrive best. This is mere conjecture, but it is founded on the argument that Nature seldom confines her arrangements to a single purpose. Under the husk is a woody shell, shaped like a boat, with a pointed prow and a flattened poop. It is nearly twice as long as broad, and its shape is better adapted to its purpose than that of our boats, since it consists of two convex shells, one of which may serve as a keel, the other as a deck, so that it can float either on its side or on its back. This nautical form is given to it by Nature, as well as to the seeds of all vegetables destined to grow either in water or along its banks. These two shells joined together contain two lobes, divided

partly by a thick membrane, and united towards the point, in which is contained the germen or first lineaments of the walnut; these two lobes are covered with a pellicle. The walnut, when fully ripe, falls from the tree, rolling, in consequence of its round shape, to a sufficient distance to prevent its future vegetation from being cramped by the parent-tree. A neighbouring stream sometimes carries it a great way off; but it more commonly remains on the ground, and is protected from the frosts of winter, by the leaves which fall in autumn from adjacent trees. In spring the moisture of the earth aided by heat swells its two lobes, the effect of which is to open its shells. The germen now appears and extracts its first nourishment from the two lobes, which have by this time become fitted to supply alike two nipples. Meantime there proceeds from the lower parts of the germen a radicle, which, by an inconceivable mechanism, directs itself downward, while another rises upward. The radicle divides itself into fibres, and sucks, in the earth, emanations of what I have called the subterranean waters; while the germen, dividing itself into leaves, collects the vapours of the atmosphere, or aërial ocean. This double operation takes place whatever be the situation of the walnut; if it is turned up-side-down the ger-

men acquires an erect posture, while the radicle points downwards. Such is the first stage of vegetation when coming out of seeds of all descriptions; but common as it is of occurrence, it is not by any means easily comprehended. The stones in the bosom of the earth do not force the germen to point downwards, nor does the rain attract the radicle aloft. These two organic parts of the vegetable have their determinate harmonies, the one with the aërial, the other with the subterranean waters. They tend to prove the existence of deposits of water in both situations, although not open to common observation. If the subterranean ocean did not exist, no seeds could be raised in Egypt, in Peru, and in other countries in which rain seldom falls. The roots in those countries are consequently moistened and attracted by the transpiration of the water under the surface of the earth. Were the mere moisture of the air sufficient to produce this attraction, the roots of our vegetables in rainy countries would all point towards the surface of the ground; but the case is so different, that we find them sometimes penetrating to astonishing depths in despite of every obstacle. In the moist atmosphere of the hills near the river of Essonne, I have seen vine-roots penetrating more than fifteen feet downward, across a quarry of

lime-stone. How can we account for this otherwise than by the existence of water under ground, the emanations of which penetrate the thickest layers of stone, and harmonize with the roots of plants?

The maternal precautions adopted by Nature to protect seeds from the injuries of the elements and of animals by no means operate as obstacles to their growth. Seeds enclosed in hard shells are disengaged by means of seams, or by small holes. The shells of filberts, though apparently of a single piece, are pierced with a number of almost imperceptible openings, and I have seen some little girls so dexterous as to put a hair of their own, or even a horse's hair, through them. The cocoa, the largest, no doubt of the nut species, has three of these openings, which give it the appearance of an ape's head. They are covered by a slight pellicle, whence the germen proceeds; and I am inclined to think that the cocoa has seams likewise, for there are negroes who contrive to cleave it with a stick into two equal parts. The case is probably the same with all nuts or kernels which appear to consist of a single piece. I have observed that the kernel of the peach-tree, called Venus's breast, is often cleft in two, even in the fruit, after which we find its almond consumed by a kind of mouldiness or

insect. But what appears to me extremely singular is that the kernel, on being cleft in two, although very hard and well shaped, should be sometimes broken into fragments, without our being enabled to perceive how such fractures could have taken place in the case of a hard substance inclosed in a soft fruit. Can this be the consequence of any electricity, vegetable or animal?

Be this as it may, the radicle, after penetrating into the ground, becomes converted into roots, which often diverge from each other, and serve, of course, to maintain a direct relation between the ground and the vegetable. These roots conduce to the nourishment of the fibres of the stalk with which they respectively correspond. It is a singular fact, that their growth is directed much more frequently towards the east, the south, and the west, than towards the north, a circumstance which proves the influence of the sun even below ground. The same holds in regard to the fibres of wood, which are closer on the northern side of the tree than on any other; these roots are generally subdivided in a variety of directions, and are frequently found to correspond, in point of number, with the branches of the tree. The palm-tree, which has no branches, and which bears only woody

leaves, is found to have only one root, covered, it is true, with a multitude of fibres. It is these fibres which act as suckers, and form in a manner the bowels of vegetables. They extract water from under ground, and change it into sap, which is afterwards elaborated into wood, bark, leaves, flowers, and fruits, by the continued action of the sun. Attempts have been made, but in vain, to give an explanation of this wonderful change. It seems beyond the powers of human knowledge to comprehend in what manner sap can be made to assume a saccharine character in the pulp of a fruit, a stony in its kernel, an oily in its almond, a bitter in its leaf, and that of an insipid wood in its trunk. Again, we find that the same soil may be made to produce wholesome aliment and deadly poison; a new proof that the operations of Nature are never likely to be comprehended by our limited understandings, and that we shall do well to confine ourselves to a consideration of the results. A knowledge of first causes belongs only to him who is their director; but final causes are within the reach of man, who enjoys the fruit of their operation.

The more numerous the fibres of a tree, the greater the portion of nourishment which it extracts from the ground. It is consequently a

sound maxim in agriculture, to cut off a part of the thick roots and of the branches of a tree on transplanting it; for the roots will then produce a quantity of fibres, so that there will on one side be a large supply of subsistence, and, on the other, a limited quantity of wood to subsist.

Water extracted by means of roots is called lymphatic, because it differs very little from pure water. It rises first by means of tracheæ or aërial tubes in a spiral form, along the longitudinal fibres of the wood. These fibres are a kind of channel, in which the water might rise without tracheæ, as in capillary tubes; but the concourse of several elements is, no doubt, necessary in the formation of the sap. The fibres of the wood, apparently close to each other, now separate, and contain between their openings vesicles, called in French *utricules*, from their resemblance to *outre*, a small flask. They are of an oval form, and lie in succession mouth to mouth, between the fibres. They extend from the circumference of the tree to its centre, and from the bark to its pith, which itself appears little else than a long channel filled with larger vesicles. Those which proceed from the circumference to the centre are arranged by planes placed, one above the other, in all the parts of the trunk where a separation of the fibres takes

place. It is to their horizontal direction that we are to ascribe the ease with which a tree may be cleft from its circumference to its centre, as is more particularly apparent when they happen to be suddenly dried, it being the nature of wood to undergo contraction in a dry state, and to expand in a moist one. As these vesicles succeed each other throughout nearly the whole length of the tree, it is a matter of little difficulty to cleave the trunk, the chief resistance taking place at the spots where the woody fibres approximate.

I shall not here enlarge on a description of the stem of trees, composed as it is of vesicles and fibres. Its connexion, when physically traced, will be found to hold chiefly with the winds; nature giving wood only to the trees and the bushes, which, from their elevation, are exposed to the blast. *Gramina* have very little wood except in their roots; even the bamboos, those vast reeds of India, and the palm-trees, have, properly speaking, no wood, notwithstanding their power of resisting the fury of the hurricane.

The leaf of a tree has, by its lower side, a relation with the vapours arising from subterranean water, and by its upper, with those falling from the water in the atmosphere. It is generally shaped, as is well known, in the form of a tongue; and the short stalk, by which it is

fastened to its bough, is furrowed in the middle. The bough forms with the branch, and the branch with the trunk, angles of thirty or forty degrees, and the trunk has its bark fluted with longitudinal crevices. By means of all these dispositions, rain-water runs from the leaf to the bough, from the bough to the branch, from the branch to the trunk, and from the trunk to the roots, from which it proceeds, when very abundant, to the subterranean deposit.

The circulation of rain-water is the same on the surface of a tree as on the surface of the ground; it falls in the latter case on a rock, which attracts it in vapour as a leaf. It thence passes successively to the spring, the rivulet, the stream, the river, and the sea, which form among each other a succession of the branches, similar in some measure to those of a tree, as may be seen by inspecting a map. The shape of leaves differs according to particular species of vegetables, being similar to a bird's beak in broom, to cockle shells in buck-wheat, and to scoops in grass at an early stage of their growth. The leaflets of the pine are aggregated in the pencil form, and collect the smallest vapours of the air. It is in the bosom of the torrid zone that vegetate the cochineal or melon thistle, the torch thistle, and other species of *cactus*; aloes, and all kinds

of succulent plants, the leaves of which seem little else than sponges replete with water.—These vegetable springs and cisterns, these aqueducts in the shape of leaves, are found only in vegetables peculiar to mountains, or to arid spots in perpetual want of a supply of water. Plants growing in a moist situation have a shape and arrangement altogether different, although they often belong to the same genus. Their leaves, far from attracting water, repel it; it glides down their sides without wetting them, or it collects on them like drops of quicksilver. Such are the leaves of the nymphææ which float on the surface of ponds without absorbing moisture; such are also the leaves of reeds and rushes. The leaves of these different plants have no channelling to conduct rain-water to their roots, while the mountain-rush is scooped throughout its whole length. The leaves of the poplar and aspen trees have long pedicles, and are moveable; other trees, instead of pointing their branches upward, extend them outwardly, like an arch, as if the object was to keep the rain away from their stalks. Such, in general, is the natural growth of the osier and the willow, unless it be altered by repeated cuttings; in which case it grows in the manner of the willows of Babylon. Finally, other trees have their leaves arranged one

above the other like tiles on a roof; this is the case of the walnut and horse chesnut.

Of all these I have given a sufficient number of examples in my "Nautical Studies." It is certain that, as vegetables produced in mountains have sub-genera, which admit of being planted in a variety of situations both as to the wind and the atmosphere; aquatic vegetables have, in like manner, sub-genera, in harmony with water in all its divisions of ocean, ice, clouds, or subterranean moisture. We might even establish a relation between the water deposited in the vegetable world, and the parasitic plants which extract their support from the sap of vegetable products, as the misletoe, the scolopendras, lichens, agarics, and mosses. The harmonies of Nature, wondrous as they are in large objects, are still more wondrous in the small. They are multiplied in the inverse ratio of the space they occupy; the structure of a stalk of moss is more surprising than that of a cedar tree, and the formation of a gnat is more curious than that of an elephant.

Mosses form so numerous a sub-genus of plants, that Le Vaillant, the botanist, counted no less than a hundred and thirty-seven species of them in the neighbourhood of Paris, which was more than in any other genus of vegetable. He would have found them still more numerous in

the north, which is their native country. They approximate, in the opinion of Adanson, to the family of pines by the disposition of their leaves, and by the cones of their female flowers. Some mosses, like the phascum, have only four lines in height, while others are five or six feet in length, like the lycopodium; but the latter, it is proper to observe, creeps along and takes root in different parts. Mosses have cups, sometimes provided with veils (calyptra), and sometimes without them; these are flat in some, but in most they are terminated like the point of a needle. In the midst of these cups is a dust, taken by some naturalists for the pollen of moss; by others for their seeds. The interior contour of their covering has one or more rows of elastic filaments, which become erect by degrees, and, at the time of fructifying, make the covering burst suddenly with the seeds contained in it; the cup may then (if we may assimilate small things to great) be compared to a mortar sending forth bombs. This dust, whether merely fertilizing, or formed of seeds, is similar to flowers of sulphur; and that of the lycopodium is very inflammable, for when thrown on the flame of a candle it takes fire like gunpowder. It is made use of at the Opera House in Paris in torches, with spirit of wine, which, on being shaken, throw out

flames of fifteen feet high. Our fingers do not admit of being moistened after having this powder pressed on them, and it may be remarked, in general, that mosses are the best preservatives against damp. The kind of moss called fontinella, from growing in the neighbourhood of springs, is altogether different from the seeds of the lycopodium; it can neither preserve nor communicate fire, for it becomes reduced into a cinder without sending out any flame. It may accordingly be used to preserve from the danger of conflagration such parts of carpenter's work as are too near a fire place. Mosses preserve their vegetable properties during a number of years, for even after being long in a dry state they recover their green colour on being moistened. At the same time we can hardly be said to make them grow where we wish, since they very frequently shoot up where they are not wanted.

I shall say nothing here of the *nostoc* or fugitive moss, a species of membraneous lichen, which appears on the ground immediately after rain, and disappears with the wind; nor shall I enlarge on the aquatic moss or sphagnum palustre, composed of silky filaments of beautiful green; nor on the conferva, a species of byssus composed of filaments which have neither roots, flowers, nor fruits. I shall cast, by preference, a

glance on plants growing on the side of rivers, or by the sea-shore, the nature of which has hitherto very little engaged the attention of botanists.

There is a multitude of plants which grow not only on the borders of waters, such as the salicaria with purple ears, the yellow iris; the fragrant mint; but there are many which come forth even in the bosom of water itself, such as cresses, duck-weeds, flags, rushes, the nymphææ, and the sagittariæ, so called because their leaves have the shape of an arrow-head. Others again are entirely submerged; this is the case in particular with a plant with long filaments, the extremities of which are jointed like the claws of a lobster. It is a curious fact that all these river plants open their flowers on the surface of the waters, so that a rivulet in summer often looks like a portion of a meadow. Little birds perch on those plants, and I have more than once seen the wagtail run thither in pursuit of the insects which hover over the stream. The conclusion is that solar influence is indispensably necessary to the flowering of these as of all other plants, and that they were intended to embellish the abode of man; for the borders of the sea present nothing of a similar description. The flowers of river-plants seem intended, by their colours and their perfumes, to furnish crowns, girdles, and nose-

gays to our shepherdesses and our female bathers; while sea-plants, by their glutinous and elastic qualities, seem destined to facilitate the running aground of barks, and the landing of sailors and fishermen.

Plants growing in the bosom of the sea are governed by other vegetable laws than those which come into flower at the surface of the earth and of fresh water. They are hitherto so little known as not even to be introduced into a nomenclature. Persons are in the habit of giving them the names of fuci and algæ, with just as little propriety as if the general name of grass were applied to all the vegetable products of the earth. Were we to judge of the number of sea-plants by that of sea-animals, the probability would be that, in consequence of the greater extent of sea than of land, the quantity of vegetables must be comparatively larger. Our knowledge, however, is confined to the plants growing on our shores, or brought to us by currents; and although we are apt to make a great boast of our progress in natural history, our acquaintance with sea plants is as yet only in its infancy.

There exists a much greater variety of colour in sea than in land plants. I have seen them white, grey, green, lemon and rose coloured, purple, brown, &c. so that it seems that Nature,

in refusing them flowers, has given them a counterpoise in point of brilliancy. They might in all probability be useful for dyeing, though hitherto little applied to such a purpose. It is remarkable that few, if any of them, are blue, for the sake, no doubt, of preventing them from being confounded with the azure of the sea. It happens, in like manner, that we very seldom see plants on land of the colour of the soil which bears them, as they could not, in that case, be distinguished by the animals for whose use they are intended. Nothing can be more erroneous than the notion of those who wish to establish simple attractions and mechanical coincidences in the works of Nature, which will be found to present us in all directions with ingenious contrasts.

The various species of sea-plants differ from each other as much in shape as in colour. We have them of all descriptions: some like shrubs, others like lettuce-leaves, long straps, or smooth cords; some with knots, others with husks, and with fruit in the form of fingers, or with long fibres; and finally some like bunches of grapes, as those which bear that name under our tropic. Some of them float, without seeming to be fastened at all to the earth, at the bottom of the water; while others have roots which take hold of bodies apparently the least fitted for such a purpose, I

mean pebbles, and even bottles. Some plants rise to the surface of the waves by means of small bladders full of air; others have large leaves like a fan pierced with holes, through which the water runs as through a sieve; such are the *panaches marins,* (*ulva lactuca,*) which grow in narrow parts; some are found vegetating like down on the crust of shells; while others, such as are seen around the Kerguelen Islands in the direction of the south pole, rise from a profound abyss, and are supposed to be frequently of not less than three hundred fathoms in length. All sea-plants, even those that are most under water, have a relation with air. They possess the means of separating it from water by a mechanism of no less delicacy and complexity than that of the gills of fishes, a reference to which is commonly made by way of enabling the student to comprehend the structure of those plants. One of the most extraordinary of them is the fucus giganteus, described by Roblet, surgeon to Captain Marchant, in his voyage to the Charlotte Islands in the Southern Ocean. It differs from the one described by Forster in his account of Cook's voyage, in as much as it has branches, and as its stalk and branches are pipes full of air from one extremity to another. Each of them had attained a prodigious height, more indeed than 300 fathoms; that of Roblet

was of 314. The nature of its vegetation is equally curious as its magnitude. At its extreme point at the bottom of the sea it is not thicker than the finger, and it goes on acquiring progressive breadth until it reaches the surface of the water, where it is terminated by a hollow ball surrounded with foliage. It is covered with barnacles from one end to the other, and supports itself in the water only by means of the air which it contains; for, when cut, its different parts sink to the bottom.

It may be laid down as a general rule that sea-plants have their stalks thicker at top than at bottom, while in regard to land-plants the case is quite otherwise. The reason evidently is that in the former the top of the stalk supports the lower part, as much as the bottom supports the top in the latter. A sea-plant is held up in all its parts by water, while on land a plant bears in all directions on its base, which consequently requires strength in proportion. Nature deals neither in excess nor deficiency; her harmonies are so accurate that the land-plants which take hold by tendrils or spirals, and which consequently do not press on their stalk, are smaller below than above; this is the case with peas, French beans, &c.

We may at some future day find it practicable

to go down to a certain extent in the water, by means of an air-tube made out of the fucus giganteus. It might possibly serve as a proboscis to respire the air, and we should not then have to dread the compression of the atmosphere as in the diver's bell.

Each coast produces sea-plants of a similar kind. I have seen at Dieppe some specimens of white and branchy fucus in a spiral form, in nets which were cleaning by fishermen lately returned from the crab-fishery on the coasts of Scotland. There were among them various other specimens not common on our coast, and the cleaning of these nets might have supplied additions to the most curious cabinets. There is not only a great number of stationary, but also of migratory sea-plants. On returning from the Isle of France, I saw, during an extent of more than eighty leagues, the sea covered with the plants called tropic grapes, which are commonly supposed to be brought from the shoals of Florida. This, if correct, would form a new proof of the current of the Atlantic proceeding in summer from north to south. But as in winter the northern shores of that sea are covered with immense quantities of the vegetable in question, the conclusion is that in that season it is carried to

the north. The inhabitants of the coast are in the habit of turning it to account in manuring their land, or in making soda. It is consequently carefully collected by the inhabitants of the coast of Bretagne, Normandy, the Scilly Islands, England, Scotland, Ireland, the Orkneys, and even of barren Iceland, where it is sometimes used as pasture for cattle.

Yet, amidst all these maritime vegetables, numerous and vigorous as they are, we find none fit to be compared to the trunk of a tree in point of size or solidity; they are all thin and elastic like the grassy tribe. It seems to have been the intention of Nature to give, during winter, to the amphibious animals of the north, a soft and warm couch, which she has refused to those of the south, the strands of the latter affording only sand and mangroves, whose lofty foliage presents a shelter from the heat. It is singular that the madrepores, a class of stony vegetables, the fragments of which produce so many accumulations, are found in abundance on the shores of the torrid zone, and very seldom in those of the temperate zones, while in the region of frost they are wholly unknown. On the other hand pliant sea-plants, such as fuci and algæ, are of considerable size, and extremely common in the icy

zône, less common in the temperate, and hardly to be found at all in the torrid. Yet these two products, dissimilar as they are, seem to have certain analogies; for neither of them bear flowers or fruit, and each emits, on being burned, a disagreeable smell of fish or of insects. I should be inclined to place them both in the class of polypi, under which some land-plants might likewise be comprised, as animalcula are found in abundance in their sap.

Although the anatomy of sea-plants is still unknown to us, it is clear that they are in harmony with all the powers of Nature. They grow at the bottom of the sea, but they take root on sand and rocks. They absorb air mixed with water, as is apparent in the case of such as have air-bladders, and they do it by a process similar to the respiration of fishes through their gills. The solar ray, that inspiring principle of all created beings, penetrates even to them, and brings them not only heat but light. Were this not the case, there would appear little reason for giving eyes to fishes. There seems very little doubt that the rays of the moon are perceived even in the depths of the ocean, since fishes are observed to regulate periodically their migrations, and their time of spawning. As a farther proof of the influence of

the moon, it is to be observed that shell-fish have their shells marked with a streak for every month they live.

These observations refute the notions advanced by Bouguer in regard to the effect of moon-light. That astronomer goes the length of alleging that moon-light is only the three hundred thousandth part of that of the sun, a conclusion which he founds on an experiment made with a certain number of glasses placed above each other, through which the solar rays were made to pass until reduced to the faintness of moon-light. But were his conclusion well founded, not only would moon-light be incapable of penetrating the surface of the water, but even the solar rays would go a very little way, since water is infinitely more compact than all the glasses which we can place above each other. Bouguer needed only the testimony of his eyes to see the error of his proposition. How could he possibly think that moon-light is 300,000 times weaker than day-light? Shade is understood to bear a proportion to light; and does this extraordinary inequality exist in the shadow of the substances enlightened by the two orbs? If Bouguer, brought up in obedience to academic rule, required the demonstration of physical experiments to believe what any one may see with a glance of the eye, he had

only to shut the blinds of his room, and make a hole in one of them so small as the three hundred thousandth part of the apparent extent of the sun's disk, (which is about a foot in diameter,) and he would very soon have seen whether the glimpse of light thus admitted was to be compared to moon-light. I have in one of the blinds in my room five holes, each of more than half an inch in diameter; yet the rays of the sun pass through them without rendering visible the objects at the end of the apartment. Bouguer fell likewise into an error when, in his Treatise on Navigation, he limited to one degree the greatest refraction of the sun on all the horizons of the globe. Borents had proved that this refraction was of two and a half degrees on the horizon of Nova Zembla, where he saw the sun a fortnight sooner than the regular time of his appearing. It is true we may conclude from this that the earth is extended in length towards the north, while Bouguer, by another error, supposes it is flattened. Again, in another passage, he not only falls into a mistake, but contradicts himself in affirming that the moon has produced tides by her attraction; for he has elsewhere acknowledged that the high tides do not take place until thirty-six or forty-eight hours after the passage of that planet over the meridian.

I am inclined to think that there is no error,

even in natural history, which does not proceed from some moral error or defect. Bouguer aimed at supporting the experiments of the celebrated Buffon, who denied that there was any heat in the lunar rays; and he consequently sought to weaken, as much as he could, the extent of light proceeding from this celestial reflector. He was, on the other hand, a great partisan of the doctrine of attraction, which he wished to apply universally; preferring calculation to evidence, and the authority of Newton to the testimony of his senses. He was a thorough convert to the new school and faithful to his creed, because he was indebted to it for his post of astronomer. It is with pleasure I add that he discovered equal fidelity to the cause of his country. On being appointed, along with two other Academicians, to measure an arch of the meridian near the equator in Peru, he went through his duty without evincing either a quarrelsome, an ambitious, or a covetous disposition. He was the only one of the three who returned to France and to his Academy, as soon as circumstances permitted it. His errors were rather of his system than of himself, and if I have pointed them out somewhat minutely, it is because they are found in a book of good character, and for the sake of preventing the future generation from falling into a mistake

on the authority of a writer who has weight in the eye of a number of naturalists. To succeed in arriving at a knowledge of truth, we must shake ourselves loose from the prejudices of family, of sect, and even of our nation.

Let us now leave the varying systems of men, and return to the permanent laws of nature. We have already classed each of her kingdoms under twelve principal harmonies, which divide them into genera. Each genus might be referred to the same harmonies, and the result would be at least 144 positive, and as many negative species. A similar course would give us the minor species or varieties. If we apply this method to sea-plants, it will have the effect of classing them all in their natural order, as well as of leading to an accurate knowledge of their shape, and consequently to the application of appropriate names. *Rem verba sequuntur*—nothing suggests so clear a designation as defining what a thing is. Hitherto we have been in a state of complete ignorance in regard to sea-plants, having hardly bestowed on them a dozen of names, while in fact they are as numerous and various as the long list of terrestrial plants. It seems very likely that there exists between sea-plants and sea-animals the same kind of relation as between plants and animals on land. Were even all marine vegetables of the class of

polypi, they would notwithstanding be conducive to the supply of the wants of fish, several species of fish in the south having a bony palate which enables them to bruise coral.

We are then justified in referring the madrepores, which in a manner pave the seas of the torrid zone, to solar influence, and in allotting sea-weed to the frozen zones. Although all these vegetable products grow in the bosom of the water, there are some sea-plants which belong particularly to air, and are to a certain degree amphibious. Of this description are several species of *fucus* stuck on rocks, which the sea covers and leaves bare in its flux and reflux. The leaves of this plant are shaken by the wind like those of a forest. Other plants have a relation with the land and ocean, and answer the purpose of protecting its shores against currents; such is the sea-weed of the North, and the madrepores, the latter of which are found to cause an imperceptible augmentation of the circumference of the islands situated between the tropics. Several of these islands indeed owe their existence, as Captain Cook observed in the South Sea, to this curious production of Nature. It was perhaps from their fragments that were formed, in remote ages, the calcareous stones, the marl and the marble, which constitute the soil of the greatest

part of the earth, and particularly of Europe. Strange! that sea-animalculæ, hardly perceptible with a microscope, should be instrumental in giving increased magnitude to our globe.

——— Omnia vincit labor
Improbus.———

There is no force, however small, which may not acquire power and preponderance by constancy of operation.

The animal harmonies of sea-plants are equally to be admired as their terrestrial. The sea-weed of the North serves for pasture to a multitude of insects, which in return afford nourishment to enormous fishes of the whale species. It is, no doubt, to the existence of these plants, so common and so large towards the polar circles, that we are to attribute the surprising quantity of fish caught in the northern seas, where the species are undoubtedly more numerous, more varied, and of larger bulk, than those of the seas of the torrid zone. Some of those sea-plants may be made useful at the hand of man, and may be employed either as manure, or for the manufacture of soda. How many of those that are yet untried might be found useful for dyeing materials, and even for food. The Chinese, and particularly the Japanese, find it practicable, by a previous pro-

cess, to extract some agreeable dishes from them, in the same way as we do from the bitter olive. Can there be among sea-vegetables a tougher or less savoury substance than the coffee-berry, of which both Indians and Europeans have found the means of making so pleasant a drink? What great results might be obtained from the properties of different saline products when operated on by fire?

Sea-plants are likewise conducive to what I have termed "the moral harmonies of the world." Some of them are grouped in fraternal order, like those which we see methodically arranged on the top of rocks; others, by gentle contrasts, put on the ornaments of conjugal harmony! Such are the corraloids *(coralloïdes)*, so varied in shape and colour. A third description form a junction at the surface of the water, and are sometimes even made to serve as rafts to affectionate couples. We see often, in the neighbourhood of the Cape of Good Hope, the male and female of the sea-calf float together on the *trombe (fucus buccinalis)*, which is no doubt hollowed, and afterwards swelled, for such purposes, by Nature. It is said to have been on a bed of sea-plants that the Venus of the Greeks sprung forth from the bosom of the waves. The Chinese likewise relate that the Goddess of Love arose from the bosom

of a flower which sprang up in the midst of the waters. These traditions deserve notice, in as far as they discover in each people a conviction of the same harmonies. A great number of sea-plants are appropriated to what we have termed "maternal relations," serving for the purpose of sheltering and transporting the fry of fish stuck fast to them. Not unfrequently does it happen that halcyons and small land-birds, or even slender quadrupeds, build their nests on them, and float with them towards unknown islands. These masses of floating vegetation are sometimes so extensive as to interfere with the course of vessels; a circumstance well known to occur in the Gulf of Florida. Other sea-plants appear intended to point out a limit, and trace a line of demarcation on the liquid levels of the deep. This may be useful in fixing the boundaries of the different maritime powers, and in affording to navigators points of greater certainty than their computed calculations of longitude.—Again, other species of sea-plants make, like navigators, a circuit of the globe, and are rolled by the sweep of the ocean from one pole to another, Perhaps among these moving species the ill-starred mariners, wrecked on a desert island, might find the means of choosing fit materials for a communication of their unhappy condition to the inhabitants of the

borders of the ocean. The thickness of their leaves and stalks renders them fit to receive any kind of inscription; and it is easy to collect a quantity of them so as make a conspicuous appearance, and point out to any vessel that might be passing the scene of a shipwreck.

In this manner the most barren strand, and the rock beat by the tempest, may afford to a man remote from his fellow-creatures the means of support, as well as objects of consolation and hope. When a boy, I was in the habit of going frequently to the sea-side and of sitting down in the recess of a cliff white as snow. I used to place myself in the midst of its fragments, which were decorated with *fucus natans* of every colour, and dashed over by the foaming waves. There, like Chryses, as represented by Homer, and doubtless as that great poet had himself experienced, I derived consolation from venting my complaints of the tyranny of man to the orb of day. My imagination whispered that the winds and waves participated in my grief by their murmurs. I saw them advancing from the end of the horizon to furrow the azure surface, and to form around me a thousand marine garlands. These distant and confused sounds, this continued motion, plunged my soul into the pleasantest reveries. I looked with admiration on the plants sown by the hand

of Nature on the upper part of the rocks, and braving all the fury of the tempest. I occasionally saw the children of the poor inhabitants of the neighbourhood come cheerfully with their baskets in quest of crabs and periwinkles. I could not help remarking that they were much more comfortable than I, whose school tasks were at that time a subject of great anxiety. Montagne relates that he one day brought into his castle a poor boy whom he had found engaged in this vagrant occupation; but the youth soon got tired of his new abode, and preferred a return to his former mode of life. Montagne ascribes this taste to our wish of liberty; but in my opinion it is likewise connected with the powerful harmonies established by Nature along the sea-shore. It is they which induce the half-clothed Patagonian to continue to wander in the midst of the frosts and tempests of Cape Horn. He prefers the strand, foggy as it is, to the fertile plain of the interior, and his rude industry to all the arts of Europeans. Nature has placed the cradle of liberty in the garden of the Nereids. It was not on the summits of lofty mountains, but on the borders of the ocean, that the first republics were formed. In spots like these the wildest solitudes are peopled, and plenty is enjoyed in the midst of the sublimest scenes of Nature.

Aquatic Harmonies of Animals.

We have already pointed out five grand divisions of water, and we may now add a sixth, namely, that which is absorbed by animals, and which is useful in renovating their blood and humours. All the divisions of the aquatic kingdom are modified by the positive and negative action of the sun, an action combined in its various processes with that of the other powers of Nature.

Animals take in fluids by what are termed positive organs, such as beaks, lips, tongues, trunks, and, after having filled the bladder and lymphatic vessels, they evacuate them by means of negative organs. Beaks are formed of a horny material, and are used by birds in taking in their solid as well as their liquid food. Some of them drink water as with a spoon, as in the case of a fowl, which raises its eyes at every draught; others absorb it at a breath, like the pigeon, which has the beak a little fleshy that the two parts may make a better vacuum; a duck has a beak broad at the point, and drinks as it waddles along.

The lips are, as is well-known, a kind of membrane with which quadrupeds attract water by forming a vacuum, as we see in the case of a

horse and an ox. Tongues are to animals vehicles of water, as leaves are to vegetables, and they afford likewise the means of raising a sound or murmur. It is remarkable enough that both are shaped in nearly the same manner. A cat uses its tongue to lick water like the lion, the tiger, and the dog, who has a very long and very thin tongue, and makes in lapping the water a kind of trunk with which he attracts it. Fish have short and immoveable tongues fastened to their lower jaw. In consequence of this conformation they are dumb, and, in fact, have no occasion for the faculty of making a noise in an element which is not sonorous.

A trunk is met with chiefly among insects, and is used for sucking in their drink. Blood-sucking insects have a trunk of a particular shape. An elephant's trunk is little else than a prolongation of the nose, or a kind of pump to draw in water, which he afterwards throws into his mouth; but in insects the trunk is a throat and not a nose, their breathing taking place through the tracheæ.

It admits of no doubt that fish drink, as it is evident that they perspire. Their gills probably enable them to separate fresh from salt water, as they are known to enable them to separate air from water. It is a very curious fact that sea-fish have no saltness either in their lymph or

blood, and sea-faring men, under the pressure of thirst, have been said to derive relief from drinking the blood of sea-tortoises. Nor have fishes any thing in the shape of a water-bladder, as they stand in no need of a reservoir in the midst of an element which they may swallow at all times. It is, no doubt, on this account that they have very little either of blood or of lymph; but they have an air-bladder, which enables them to rise and rest in the water when they dilate or compress it, or when they wish to extend or contract the space which they occupy.

The exterior aquatic harmonies of animals will be found to bear a reference to the six divisions or repartitions of water already enumerated. Animals of the frozen zone are in general covered with long hair, as a protection against the snow; and the same holds in regard to those which live in the glaciers of high mountains, and whom Nature has protected with a thick fur. Her maternal precautions have been extended even to the animals of our climate, whose fleeces and hairy coverings are longer and more tufted in winter than in summer. Some species have particular organs in connexion with snow, as the elks and rein-deer of the north, whose horns are branchy and flattened. They make use of them

as of spades and shovels to clear away the snow lying over the moss and the plants on which they live. Snow itself is a kind of mattress with which Nature covers grasses in winter to preserve them from the intensity of the frost.

Most animals have harmonies with the portion of the watery element suspended in clouds by the shape of their body and their muscles. These are disposed in the most favourable manner, not only to let rain-water run off, but to conduct it from the summit of their head to their excretory organs for the purpose of washing and cleansing them. They have moreover their hair and their feathers arranged one above the other like the tiles of a roof.

The terrestrial ocean is divided, according to our former definition, into running streams and rivers, and into those subterraneous waters which furnish an incessant supply to our wells and our vegetation. A number of animals have relations with the former, of which we shall treat by and by, and some are in harmony with the subterraneous waters. It is thus that beetles (*scarabæi*) live under ground, and have their wings covered with a scaly coating as a protection against damp. Several have an oily covering, as the dung-fly, and the insect called, on account of its colour,

the capuchin, which passes the cold season under ground, and carries its young on its back, which is flattened like that of a tortoise.

A number of insects are in harmony with that portion of fluid which constitutes the sap of plants; such are those which live on the surface of leaves and fruits, and extract their juices; such also is the cochineal-insect, which gives us the rich colour of scarlet. Mexico is properly their country, and they are generated on the thick and thorny leaf of the nopal, which they begin to suck as soon as they are hatched. Their trunk is so brittle that we cannot move them from their place without breaking it, and making them expire; the consequence is that they remain fixed during life to the spot where they were born, and to the vegetable nipple which feeds them. But when the females have attained the age of puberty, at the expiration of a certain number of months, the males are supplied with wings, and are enabled to quit the plant where they were born. The females remain stationary and hatch their young on the spot; but the latter would soon become so numerous as to be at a loss for space to feed on, while they are so delicate that it would be impossible for them to pass from one plant to another, did not Nature afford an admirable method of emigration. At the time

of their birth a multitude of spiders extend their nets to the leaves of the nopal, and it is along these slender threads, as along a bridge, that the brood of the cochineal-insect emigrates to the neighbouring nopals.

The fluid contained in animals, I mean their blood and juices, supplies nourishment to a quantity of insects. There is perhaps not a single animal, from the fly to the whale, that does not feed its particular insect. Many birds have a kind of winged vermin, and I have seen something of the kind on the pigeons in the Isle of France. But among blood-sucking-insects none is constructed with more surprising skill than the gnat. It has wings to carry it in any direction, six feet with claws fitted to take hold of the smallest surface, and a trunk indisputably more curious than that of the elephant. It is a pipe, divided lengthwise into two flexible parts, containing a piercer of very curious workmanship, and consisting of five or six little blades, similar to lancets placed over each other. Some of these lancets have teeth at their extremity like saws, while others are sharp like poignards.

The gnat makes use of the pipe of his trunk, as of a stake, to plunge it into the pores of the skin; he next employs the blades to cut the capillary vessels, and he sucks the blood from

them with his little trunk until it becomes full; after which, as I have already remarked, he passes a small drop of water. This drop probably rises from a bladder full of water given by Nature to flying insects to enable them to preserve an equilibrium in the air, in the same way as fish are enabled by an air-bladder to preserve an equilibrium in water.

Some persons are apt to imagine that blood-sucking insects are a mark of imperfection in the operations of Nature; but every thing in the range of her works will be found in its proper place. These insects do not abound but in hot weather, and they suck the superabundant humours from the bodies of men and animals, preventing them from indulging in too long sleep, and obliging them to have recourse to the healthy operation of bathing. The flies oblige cattle to quit the valley toward the middle of the day, and to seek fresh pasture near the mountain-top. The oestrum, or gad-fly, so much dreaded by the rein-deer, obliges the latter in summer to fly towards the north, where they find a fresh supply of lichens left uncovered by the melting of the snow. A few humming-flies serve as a kind of barrier to their numerous flocks, and keep them within the limits of winter, for which they are intended. To form an opinion of the works of

Nature, it is necessary to view them in all their extent.

The organs of insects are considerably more complex than those of large animals. An attentive study of them affords the means of getting much information as to the nature of the elements with which they are in connexion. Microscopic animals are a proof of this; among others, the *vorticella rotatoria*, which is no larger than a small grain of sand. It is found in gutters, and can support there without perishing the 50th degree of heat and the 19th of cold below the freezing point, according to Réaumur's thermometer, (144° and — 11° of Fahrenheit.) It is found in a state of such thorough dryness as to fall into powder on being touched with the point of a needle. It may be preserved for a number of years in its apparent state of death, continuing to retain life without seeming to take any nourishment. A little drop of water let fall upon it is sufficient to break it, so delicate are its organs; but if this water reach it through particles of dust, the insect opens its members by degrees, and swims in this single drop as in the ocean. It is then seen to extend from its forepart two little limbs, each bearing a wheel, whence in French its name of *rotifère*, or wheel-bearer; while from behind it extends a kind of

trident, and fixes itself on the spot as with an anchor. Its body consists of rings which serve it as legs, and it makes use of them to lengthen or contract itself like a worm. With its two wheels composed of imperceptible threads, it forms two rapid whirlpools, by means of which it rises or falls, and attracts its prey towards its mouth, which is situated between its two projecting limbs. The elephant's trunk is certainly not of equal ingenuity; I mean of ingenuity in regard to us, who are accustomed to estimate divine intelligence by our own; that is, by number and series. The case, however, is different in regard to Nature; her rule is to proportion the organs of beings to their wants. An excess of provision would be attended with as much inconvenience as a deficiency; so that every thing is equally ingenious in her works, because every thing is in its place and in due proportion. A cumbrous whale, shaped in a form not unlike that of a shoe, is equally adapted to sail along the icy sea, as the light *rotifère* in its drop of water, incessantly exposed to be thrown from the top of the roof where it has fixed its abode.

Although the *rotifère* is scarcely visible, it has below it several series of animalcula, so small that, in regard to them, he is what a whale of 150 feet in length is in regard to him. Of this

who is understood to have died of a complaint in which the vermin came out of every pore of his body, as if to avenge the death of those fellow-citizens whom he had caused to be slain in such numbers. It is evident that the small-pox contains, in the dried scales, living animalcula, which, like the *rotifère*, may be rendered active by a simple perspiration. The touch of a handkerchief is sufficient to communicate the infection of the plague; and it is a singular circumstance that the animalcula which convey pestilential infection, do not lodge in wood, metal, or stone, but in wool, cotton, silk; and, to use an oriental expression, in every thing bearing the appearance of a thread. None of these contagious maladies are conveyed through the medium of air or water; a circumstance corroborative of the notion that they owe their propagation to animalcula which require to fix themselves on bodies possessed of consistency. Finally, we shall have no doubt of the existence of animalcula, when we consider that most of the complaints mentioned above are cured by the application of mercury, which is well known to be death to all insects.

The ocean, vast as it is, owes its origin and renovation to the icy masses accumulated at the poles, and melted periodically to a certain extent

by the summer heat. It is that which feeds those icy deposits, as well as produces the masses of clouds which float in the atmosphere, and the store of waters which flow in rivers or lie in subterranean recesses. Hence the name of ocean is currently applied to the collected expanse of waters, without being given to either of the repartitions into which I have, for the sake of reasoning with precision, divided the watery world. In like manner we are accustomed to affix the idea and name of a tree rather to its trunk, and to its branches loaded with leaves and fruit, than to the roots to which it owes its existence. It is on the borders of the ocean that the various modifications of the aquatic kingdom come to a point, whether we allude to the ice descending from the poles, the rain attracted by the tides, the fogs which settle on the coast, the vast sheet of subterranean waters appropriated to the supply of vegetables, or the mouths of rivers which serve to quench the thirst of animals, and to favour those maritime excursions which enable us to extend our enjoyments throughout the globe. It was not on the summit of lofty mountains, but in the centre of the aquatic kingdom, I mean on the borders of seas, that Nature first planted the most helpless of beings, for the pur-

pose of giving him eventually the dominion of the earth.

Let us then cast a glance on the harmonies existing between animals and water. Nature has given to all animals the instinct and the means of crossing water: among quadrupeds there are but a few species which fly, such as flying squirrels, bats, or flying lizards; but all, whether great or small, are accustomed to swim. Curious as is Nature's mechanism for flying, that for swimming is incomparably more varied and more extensive. Animals must make an effort to get on the wing, but they seem to swim with the greatest ease; their bodies, however heavy, appear to be all in equilibrium with water; and it is a circumstance deserving of particular remark, that there should exist a hydraulic balance so equal in regard to a vast number of bodies, of which the bones and flesh have such a different degree of weight in the air. Nature has provided a balance in this respect among different animals by means of the cavities of their chest and stomach, cavities which are larger in land than in sea animals. The flesh of quadrupeds sinks to the bottom; while that of fish floats of itself. Besides, in the former the organ of breathing is necessarily above the floating line; so that their head must be carried per-

pendicularly, and their body horizontally. Fish, on the other hand, have their heads plunged in water, because they respire the air in that element by means of their gills. The horse swims gracefully and for a length of time; but the ox and the hog traverse the water with still greater vigour. We have remarked in the "Studies of Nature," that these two species are destined to feed on the marshy borders of rivers; and that their feet are provided with heels to prevent them from sinking in the mud. The name of Bosphorus may be quoted as one example, among many, of the power of the ox to cross a strait of some extent; and I have myself been a witness in Germany of cows swimming over deep rivers, the last carrying the herdsman on her back. Of the dexterity of the hog in swimming, I saw an example when on board a vessel in the roads of Martinique. Our boat had brought a number of hogs on board in the night, and they were put, one after another, on the deck; but scarcely were they untied, when they proceeded to the other side of the vessel and jumped into the sea through one of the gun-ports. They succeeded in making land at the distance of more than half a mile, before the boat, though ready to start and manned with good rowers, could overtake

them. Such ease in swimming in these two animals is the more surprising, as the ox has a very heavy head, and the hog carries his always towards the ground, in which he digs. We should at first imagine that they would be in danger of drowning; but Nature has not forgotten to give them a counterpoise, by making their thighs very fleshy and heavy, so that the weight of these limbs enables them to keep up their head when under water. On the other hand, the camel, the inhabitant of a sandy track, being very thin in the hinder part, and supporting its body on long legs, would easily lose its equilibrium; but it has the instinct to lie down on the water like a bladder, and to cross rivers by going along with the current. I happen to know several villages situated on the banks of rivers, which have renounced their title to lots of commons upon the opposite side, in consequence of the bridges over which their flocks passed being destroyed. Yet, as far as regarded the convenience of the animals, they had occasion only for landing-places on each side.

A numerous class of animals has been formed by Nature with the capacity of living either on land or water; I mean the amphibious class. They may be referred to the general harmonies

of Nature, positive and negative; for these harmonies are of all descriptions, aërial, aquatic, terrestrial, diurnal, and nocturnal.

Amphibious animals have, in general, feet to walk on, and organs which they use as oars. These oars in aquatic birds consist of small pellicles fastened to the toes of those which live in the midst of the water; such as the sea-duck, the pilot, the frigate-bird, and a number of others, which take their rest on the waves, and use their feet only on the sand by the sea-shore. Others, which frequent marshes and the banks of rivers, have their toes joined by membranes to prevent their sinking into the mud; such are ducks, geese, swans, &c. Aquatic birds are shaped exactly in the way best fitted to go rapidly through the air and to swim against currents. They have small heads and long necks, which facilitate their flight, but would hurt their swimming, were they necessary for the purpose of cleaving the water, as the water would, in that case, strike against their breasts with considerable violence. But they make their way through the water, not by propelling their head, but the breast itself; and the water, gliding along their sides, strikes against their webbed feet, situated at the extremity of their body, and acting like a rudder and oars. These organs thus operate on

the water with great power, agreeably to the laws of mechanics. At the same time they have the power, when floating along the water, to take advantage of a favourable breeze. The swan opens her wings, and, with the aid of the zephyrs, swims up the course of rivers, along the side of meadows and by the shade of forests. The albatross, more courageous, sails in the middle of the sea at a distance from, and even out of sight of, land. On the back of the waves he looks like a sheep on the sides of a hill; a circumstance which has made that bird receive from our seamen the name of that quadruped. The sight of him announces to Europeans their approach to the Cape of Good Hope. He calmly sees the pale seamen reef their sails and repair their masts, while he sports in the midst of tempests, poises himself on foaming billows, plunges into their sides, preys on the fish that are there, and, rising aloft at night-fall, carries to his young the capture of the day. Man seems to have taken the shape of this bird as a model for his first skiff, with its sails and its rudder; but where is the Archimedes that can, like Nature, unite in a single machine the vessel, the balloon, and the diver's bell?

However easy may be the movements of amphibious birds on the waters, they are not, however,

to be compared with those of fishes. We shall now proceed to take a view, first of the inward, and next of the outward shape of the latter.

We shall begin by remarking that the bones of fishes are not jointed at the ends like those of birds, quadrupeds, and even of amphibious animals; they are fastened only by cartilages. The reason of this difference seems to me founded on the circumstance that the fleshy part of fishes is entirely supported by the fluid in which they swim, while the bulk of animals rests on their bones, which must accordingly be knit together with considerable strength. The same difference of construction prevails between land and water animals, as between plants vegetating in the open air or at the bottom of the sea. Sea-plants, as we have already observed, have their stalks very thin at the base, because their foliage is supported by the water; while land-plants have their greatest strength at the bottom of the stalk. It is, no doubt, on this account, that amphibious animals have jointed bones, as they frequently quit the liquid element; and that the species of fish frequenting rocks have a kind of stony and vaulted covering to protect them from the rolling of stones. So much does this distinction hold, that not a single amphibious fish is found with bones joined by cartilages like their brethren of the

deep. Again, in land-animals the jointing of the bones is, by a wondrous mechanism, more powerful in the lower parts of the body than in the higher, loaded as are the former with the greater portion of weight. The same holds in regard to the human body, as may be seen on the inspection of any skeleton. We shall there find the points of support in the bones broader, the insertions of the joints deeper, and the ligatures stronger on proceeding from the head to the feet than vice versâ; the vertebræ of the back bone having less solid articulations than the thigh bones; the thigh bones, than those of the knees; and the knees less solid than the ancles. The knees are strengthened by rotulæ to prevent the weight of the body from falling forward in walking, and the lower part of the leg is strengthened, with the same view, by the entire foot, which is little else than a collection of bones placed so as to support an incumbent weight. Quadrupeds, having twice our number of feet, have them considerably shorter.

Let us now cast a glance on the outward shape of fishes. They are, in general, covered with scales lubricated by a viscous liquid, which renders them very slippery in the water, as well as in the hands of the fisherman who endeavours to catch them. We have already remarked that qua-

druped have a fall from the head to the tail, to let rain-water run off, and that their muscles were separated by little channels and cellular membranes which guided the rain-water to the excretory organs. Birds, being covered with feathers, do not show their muscles, but they may be observed in a shower opening their wings to receive the rain; many are fond of bathing, and of plunging their head in water, shaking it afterwards in order to wet their whole body; this we often see done in a cage by canary birds and parrots. The body of a bird is almost in the form of a roof, and is, on the whole, not unlike that of a quadruped. Now fishes are entirely different in point of shape; their posture being horizontal, and their muscles not being separated by channels for the water, as they are perpetually washed in consequence of their habitual positions. Their body from head to tail consists of a single curve, for the purpose of gliding more easily through the surrounding fluid; the last circumstance applies likewise to the shape of birds, destined as they are to glide through the air: they are covered with feathers, which are so ranged as to present on the outside one continued curve.

The chief difference between the bird which cleaves the air, and the fish which cleaves the water, consists in the front part of the former (I

mean the beak, head, and neck) being lengthened and pointed, while the hinder part is rather broad. The shape of the fish is quite the reverse; his head, which is sufficiently large, joining, without any neck, the foremost part of his body, which is broad, while the hinder part is long and tapering. A fish may thus be said to resemble a bird placed the wrong way, and in truth their motions are as different as the elements in which they live. A bird flies with the fore part of his body by means of wings projecting from it, and he guides his flight by his hinder part, namely, by his tail and feet, which he stretches out as a lever serving by way of rudder. The fish swims, by means of his hinder parts, with his tail, which by its undulations acts as an oar, while he guides his course by the fore part of his body, and by means of the fins of his head. This is more particularly seen in the case of the fish that swim best, such as the thunny, the gold fish (*el dorado*), the porpoise, called by seamen, the sea-arrow; and, in the case of birds, it is perceptible in the best fliers, as the frigate-bird, the swan, the eagle, and even the swallow.

These examples might be conducive to the suggestion of useful hints in regard to navigation. Our ships have in general the shape of a fish in the bow, and of a bird, or of a shortened fish, in

the poop, their prow being broader than their stern. There is no doubt that, if their keel were longer, that is, if they had more completely the shape of a fish, they would sail with greater swiftness.

In constructing ships, it was probably imagined that the horizontal direction of the tail of a fish might be supplied by the perpendicular direction of the rudder; but their action is entirely different, the rudder being only a lever, while the tail of a fish is both lever and oar. A fish, as I have said, regulates himself by his fins, and pushes himself forward by his tail, to which he gives an undulating movement, a movement which decomposes itself in water as in the case of wind blowing on the inclined plane of a kite, which it raises in the air, and of the wings of a windmill, which it turns round. It might perhaps be possible to employ the course of a river to turn a wheel with oblique flat spokes plunged in the water in a direction perpendicular to the current. It might have the effect of turning it round, as the air turns the inclined wheels of a windmill; and perhaps such a current might give a progressive movement to an oblique and horizontal oar, as is done by the tail of a fish in smooth water. We might construct a vessel in the form of a fish, with a long horizontal oar to act like the

tail and to be undulated by the feet of a man lying flat in the vessel. I cannot help thinking that this mechanism, odd as it may appear, would be productive of rapid movement. The practicability of it is proved by the quickness with which a ship's boat may be pushed forward by means of a single oar at its stern; and those who take a pleasure in aërial excursions might attempt to direct a balloon in this way, by giving it the lengthened shape of a fish. A balloon is not like a bird, which, being heavier than air, must make an effort to keep itself there by means of its wings; it is like a fish, which is in equilibrium with water in the way that the aërial adventurer is with the air. The latter does not consequently stand in need of wings like a bird, but of a long tail to answer the purposes of oar and rudder as in the case of a fish. Nature has not given to animals swimming in the midst of a fluid which bears them up the principle of a forward movement in the advanced part of their body, but in the lower part, as we see in the case both of the tails of fishes and the broad feet of aquatic birds; whereas she has placed this power in the forepart in the case of birds, because they pass through a medium lighter than themselves. On a similar principle it is placed both before and behind in quadrupeds and polypi. Now a ship

combines all these means of making progress; it cuts the water by its prow like a fish, flies by its sails like a bird, and may in certain situations be said to move forward, like a polypus, by means of its oars. I take notice of these different approximations, not as speculations of mere curiosity, but to show that man, having derived all his inventions from Nature, may still make a farther improvement by copying her models.

Yet all these imitations of nature, useful as they are to us, are far from approaching to the grandeur of her inventions. Of this we shall soon be convinced by casting a glance on the shape of fishes, in which there is much greater variety than in that of birds. Water has many more modifications in its motions than winds. As it may be stopped, turned aside, or divided, by the unequal bottom over which it flows, it is sometimes precipitated in a cascade from the top of rocks and thrown back in raging foam; at other times it extends in a long sheet in the plains, or rushes, with the swiftness of an arrow, through a strait; at one time a calm makes it appear immoveable as if frozen; at another, the tempest makes it roll with the noise of thunder. Nature has provided fishes for all these varieties of situation; some are round, and swim like a small wheel turning with the waves. This is the

case with the wheel-fish; while others sport in the foaming billows of the shore, like the *balistæ* and the sun-fish. A different class is long and flat like the blade of a sabre; others square and broad, like the *ostracia*, swim across the smallest pools of water; and, finally, a large and heavy class, like whales, require almost as much water as a ship to keep them afloat. Some have a long beak like a woodcock, as is the case with the needle-fish and eel, which penetrate into the moist sand of the shore, and wait very patiently the return of the tide; while others brave the tempest, and fly over, with their wings, the hollows formed between each other by the waves. While these pierce the air like an arrow, others shoot after them, curving their body and afterwards opening it like a bow; this we see in the case of the thunny. It is by a similar mechanism that a salmon succeeds in mounting the cataracts of rivers. There are large and flat fish which leap up from the calm surface of the water, and in falling back make the vast solitudes of the sea re-echo; such are the thornbacks, some of which are of surprising size. In summer they swim on the surface of the waves; the fishermen take them by means of nets (called in French *folles*) which float along with the current, and are drawn downwards in one part by lead, while

in another they are supported with cork; eight or ten barks fasten their respective nets end to end, and thus succeed in forming enclosures of more than half a league in length.

But there is no occasion to go out into the ocean to admire the variety of the shapes of fish, or of their modes of movement; for we shall find on the sea-side, and amidst rocks, the testacea and the mollusca, the swimming of which has as much variety as that of fishes, or the flight of birds. The pyramidical lepades fix themselves on rocks among the sea-weed, and might be taken for heads of nails supporting garlands of sea-grass. They fasten themselves there by forming a vacuum by means of a membrane, and remain immoveable in the most violent tempests. Cockles turned in a spiral form, and brilliant neritæ, are seen in numbers around them, and are fastened in a similar manner. The muscle, shaped like a boat, fixes itself in the sand, and remains at anchor in the midst of currents; when it changes its position, it is by means of a long leg improperly called a tongue. The sea-urchin, bristled like a chesnut, rolls on its moveable points, and pricks with them the imprudent hand that ventures to seize it. Some of the crustacea, such as crabs, sea-spiders, lobsters, and shrimps, lie in ambush in holes in rocks, and swim by

the impulse of their tails, which they spread like a fan. Others, though loaded with a covering like a roof, float on the surface of the waters by means of a sail composed of membranes; and there are some which venture into the open sea with a single air-bubble, which supports them on the surface of the water; this is the case with the small cockles, with tender shells filled with purple liquor, which I found in the midst of the Atlantic Ocean on my voyage to the Isle of France.

Some fishes are without any thing in the shape of a keel, and yet find means to sail to a great distance. I have seen, in summer, on the coast of Normandy, the sea covered with a kind of mollusca, called Flemish bonnets. Although divided into several lobes, with a great number of fringes, they were to all appearance formed of congealed water, for they fell to pieces on being touched. Still a principle of animal life exists in them, and is manifested by their motions; for they have a contraction and dilatation which raises and supports them on the surface of the waves. Their action takes place from below to above, and from above to below, like that of a pump; but the currents of the sea carry them to great distances, and throw them in vast numbers on the coast. Another species moves along

the surface of the water by the aid of wind; it is called the galley, and is of the shape of an egg, being covered in its longest part by a transparent membrane which answers the purpose of a sail. It hangs out into the sea several long filaments, which sailors call its cables. These are brilliant, and have the colour of azure and of the rose; but they burn the hand which touches them, and the pain thus caused does not go away till after sun-set. We were under apprehensions of losing one of our seamen who swam away from the ship with a basket, in order to bring some of the finest of them on board. His arms got entangled in their nets; he called out in the most distressing manner, and would have gone to the bottom without being able to make use of his hands in swimming, had he not been aided by a rope thrown out from the ship. We found the Atlantic Ocean covered with these galleys for more than a hundred leagues; this was near the equator, at the end of April; all had their sails directed nearly perpendicular to the wind, and they might have been taken for little barks moving along with round lateen sails. I imagine that, in summer, they come in quantities from the North, in the same way as the Flemish bonnets on the coast of Normandy. There is at the Isle of France a species of mollusca, of a red

or brown colour, which creeps along the reefs. On an attempt being made to seize them, they eject on the fingers a kind of white glairy matter, which is changed forthwith into a number of threads. We find in the same situation polypi of a hideous appearance, which crawl along the rocks with their seven long claws, armed with suckers. We see along the sea-shores, particularly in Europe, quantities of sea-stars, scattered by the currents on the sand, where they lie apparently incapable of motion. We find sticking to our rocks the sea anemone, a kind of living flower or animal, which opens and shuts like a purse, and shoots out water if one ventures to touch it. It is thought to be a polypus, or a collection of animalcula, which pursue their labours together, like bees in a hive. So complete a combination, both in point of labour and defence, has no doubt a claim to our admiration. Abbé Dicquemare, my assiduous countryman, has given a curious history of them. As for me, who observed the sea animals of our shores only in my childhood, and who preserve to the present day interesting recollections of them, I remember to have seen towards the middle of spring, on the strands already mentioned, in the nets prepared by our fishermen, a species of butterfly with four wings of a lively colour, which

hovered backwards and forwards at the bottom of the fens. I could never succeed in catching any of them, and I am not aware that they have been mentioned by any naturalist.

It is perfectly practicable to contemplate and enjoy aquatic harmonies without going so far as the sea-side; for our rivulets will supply us with abundance. Small as they are, these streams have, like the ocean, their feathered tribes, their shells, and their amphibious animals. It was there that the frog first gave man an idea of swimming, by pushing his fore-feet forward and his hind-feet backward. We may there see a species of fly glide along the surface of the water without wetting his feet; and the water-bug swim upon his back also on the surface of the water. These two insects seek their prey, and perhaps assist each other, when they happen to meet foot to foot. The aquatic spider finds means to walk at the bottom of the water in an air-bubble formed by its net-work, and the moth-worm in a sheath made out of the relics of plants. I have seen a species of insect, still more ingenious, form to itself a floating grotto out of cockles and small trumpet shells. The most surprising thing was that this pyramidical grotto should be crowned at its top with a small green plant, a species of cress, destined either for the

support of the animal or for keeping its little habitation afloat. There are in our rivulets a number of living creatures with whose habits we are very little acquainted. I cannot too often repeat that the industry of man has not yet attained a point to be compared with the industry of insects. The Romans were accustomed to build in water with *terra pozzuolana;* but shell-fish form their roofs of a much more durable cement, and the moth fastens her shells in the water with a glutinous substance impenetrable to moisture: an art which man has hardly yet attained.

It is Nature, no doubt, which acts for these petty portions of the creation, and which gives to the tenants of the waters both positive and negative harmonies. It was Nature which gave to aquatic birds a reservoir of oil, with which they smooth their feathers and render them waterproof. It is Nature that provided a similar oil for the sole of the gnat, which glides along the top of the springs; and it was she who covered the whale with thick and elastic rolls of fat to protect him against the cold and the shock of ice. Finally, it was Nature which appointed that animalcula, I mean madrepores, should lay, in the bosom of the torrid zone, the foundation of islands and continents.

It was under solar influence, on the sea-shore, at the mouth of rivulets, under the shade of the plaintain and palm-tree, that Nature first assigned to man his habitation, his subsistence, and the seat of his empire over animals. It was there that he first tamed the cow, which delights in running in meadows adjacent to the stream; the goose, the swan, which ascend its current, and the pigeon, which picks up saline particles along the strand. The posterity of our first ancestors increased their stock by several species of animals, by spreading themselves along the sea-shore; the Egyptian making use of a pigeon as of an aërial messenger, to give notice of the arrival of vessels; while the Chinese employed the pelican to bring him, from the bosom of the waves, the pouch suspended from his beak replete with its fishy capture. The Greeks have fabled that children crossed arms of the sea on the back of dolphins; and our posterity may perhaps succeed in training in that way the seal, which is so often met with in the fairs of France, and is said to become attached to the master that supports him. Sanguine calculators may anticipate the possibility of domesticating a portion of the inhabitants of the deep in the same way as quadrupeds. I saw, at the Cape of Good Hope, aquatic birds of different kinds walking about the

streets, and a pelican sporting with a dog. Man has found it practicable to prepare for the chase carnivorous animals of the earth and air, such as the falcon, the hawk, the ferret, and even the tiger. I have seen, in the canal of Chantilly, old carp come to take bread out of a man's hand: why then should we not hope to make some progress in bringing under our dependance the innoxious tenants of the deep? What a resource would thus be opened for increase of communication, and for relief in the event of shipwreck! Where are the limits to the eventual extension of the power of him who has learned to traverse an icy region on a sledge, the ocean in a ship, and the atmosphere in a balloon? How much may be performed by him to whom Nature has given the power of subjugating all animals by his strength, or by his kindness! To make slaves of them it is enough that he inspires them with dread; but to make them assist and follow him, it is necessary that they should be actuated by gratitude and attachment.

Aquatic Harmonies of Man.

MAN, considered in a denuded state, has neither a fur covering like quadrupeds, nor wings like birds, nor the means of swimming like fishes, yet he is the only living being capable of inhabiting every part of the globe. So far from being a machine confined to a single element, he is the director of all the machines which his own skill, co-operating with the agency of nature, can enable him to adapt to any element. On considering his relations, internal and external, with water, we shall find that all the laws of hydraulics have co-operated in their formation.

Harmony of waters, daughter of the sun, enable me to perceive this meander of the fluids which you circulate along with life in the human body; give me expressions, graceful like the undulating shape in which you delight to appear. You inspired Tasso when he placed at the entrance of the garden of Armida the nymphs who disputed the prize of swimming. The sketches of nature are still more delightful than the fictions of pleasure; its scenes increase progressively in interest with the drama of life. The rigid eye of the philosopher can contemplate them without

confusion, his chaste tongue can describe them, and the ear of the innocent may listen to them.

Our sculptors are in the habit of admiring in the ancient statues, and particularly in the famous Torso or body of Hercules, the muscles which, like waves of the sea, succeed and are lost in each other. These beautiful curves are not given to the human body merely for the sake of ornament; Nature always joins the useful to the agreeable, the substantial to the elegant; her works have no superfluous decorations; every beauty displayed there is found to be necessary. Even the brilliant and variegated colours which adorn flowers, butterflies, and birds, and which are apparently accidental, prove useful in distinguishing the almost innumerable tribes of this portion of her empire: moreover, every part of the works of Nature is destined to different uses, and her skill in this, as in every other point, is displayed to a degree which men find it difficult to imitate. An able architect, for example, does not content himself with placing a column in a building to support it, but makes subservient to an ornamental purpose its proportions, its light and shade, its elevation in the air, and even its reflection in the water. Sometimes he groups it along with groves or with other columns; he renders it a monument consecrated to love, to glory, and to the memory

of departed worth, extracting from its shape and appearance, tender, heroic, or religious sentiments, which attract the veneration of posterity. The human body is much more interesting than a column; Nature having put it in relation with all her kingdoms, and even with the Divinity himself, by the harmonies of our soul.

The too celebrated Winckelman declares, in his "History of the Art among the Ancients," that the Greek sculptors merely pointed out the muscles on the statues of the gods of whatever age, on the supposition of their enjoying perpetual youth; and he cites, in support of this opinion, certain statues of Jupiter exhibiting him in advanced years. This paradox is specious, but seems to be advanced only for the purpose of exempting the ancients from the censure, sometimes passed on them, of not giving sufficient expression to their figures; and, as one error gives rise to others, he proceeds to draw the conclusion that expression is injurious to beauty. He is right as far as regards convulsive passions, but he is certainly wrong in regard to the mild affections. A cheerful smile, or even a slight tint of melancholy, no doubt adds to the beauty of a Cupid, a Mercury, or a Venus. In regard to his assertion that the ancient sculptors merely sketched the muscles in the statues of the gods, of an advanced age, he

must either be in a mistake, or the ancients must have fallen into contradictions; for the character of advanced manhood was as indispensable to the muscles of the body of Jupiter, as to his head, where a beard and even a wrinkle were portrayed. He errs still farther in alleging that Marcus Aurelius wrote nothing but common-place, and made use of only trivial comparisons. The sublime work of the disciple of Epictetus will outlast those of all the sculptors, and will no doubt have a better claim to the respect of mankind. Winckelman has bestowed excessive praise on the medals, the vases, and the ancient statues of the cardinal who gave him a pension, while he has ventured to pass unmerited censure on a philosophic emperor, no doubt on account of his condemning this kind of luxury. Besides, this Saxon writer aimed at saying what was pleasant to the inhabitants of Rome, among whom he lived. His enthusiasm for ancient ruins is perceptible even in the title-page of his book, which he entitled the "History of the Art," as if it were the art *par excellence*, and as if there were none other more useful or more agreeable to man. Architecture, painting, music, and particularly poetry, pass for nothing in his eyes; and it deserves to be remarked that he is almost always silent about Nature, the source of all the arts.

Still he is interesting by his vast extent of erudition, his moral character, and his unfortunate exit; for he was assassinated by a traveller to whom he had entrusted himself. It is with regret that I pass censures on some of his principles, but I have felt myself obliged to it on account of his reputation; since no errors are more dangerous or more common than those which have the support of great names.

Let us now return to the harmonies existing between our muscles and the aquatic element, and let us trace them, not on statues, but on our own bodies.

The relations of man do not seem so well established with the liquid as with the aërial ocean. When he swims in a horizontal position, his organs of breathing appear in danger of plunging into the water, although this does not actually take place, in consequence of various precautions taken by Nature. Almost all our organs are doubled and placed in the same horizontal line; such is the case in regard to our eyes, our ears, our hands, our feet; but it does not hold in regard to the organs of respiration so necessary to our continuance in life. It might indeed be said that these organs are triple, as we breathe at once through the mouth and the two nostrils; but it is the mouth that conveys air directly to

our lungs, and forms the true sense of breathing. Nature has made use of various means to raise man above the water when swimming. In the first place she puts his whole body in equilibrium with water, particularly with salt water, which is heavier than fresh by a thirty-second. We may easily ascertain this in a fresh water bath, for if we lay one of our arms on the surface, it will swim and require an effort to go down. If a man happens to sink in a pool of water, a very slight motion brings him up, and he can keep himself afloat easily with his hands. Besides, Nature has enabled him to keep his organs of breathing out of water, by placing his head on the vertebræ of the neck as on a pivot, so that he can turn it easily backwards. In the next place she has put immediately under the neck the breast, which, on account of its cavities, is the lightest part of our body; while she has put our most fleshy and heavy parts at our extremities, as a counterpoise at the end of a lever. To these we may still add the weight of the calves of the legs, of the legs themselves, and of the feet; so that a swimmer, to keep himself erect in the water, has little else to do than to stretch himself out on it, in which case his feet sink and his head rises. Women are said to swim with less difficulty than men, which must be owing to the greater weight of the lower

part of their frame: Nature always comes to the assistance of the weak.

The art of swimming is frequently a source of pleasure; and the descriptions connected with it may be made conducive to the recommendation of virtue. Ulysses flying from the island of Calypso, and landing in spite of the tempest amidst the rocks of the virtuous Nausicaa, offers a more interesting spectacle than that of the Sirens who swam singing around his ship.

How great means of industry has man been enabled to set at work in situations adjacent to water. It is in such situations that most of our arts have taken their origin. The invention of the microscope is perhaps owing to the sight of drops of rain suspended to spiders' threads; while a frozen track, with its floating and transparent ice, probably suggested the magnifier, which unites the rays of the sun, and the prism, which breaks them into a thousand colours. The notion of wells proceeded, no doubt, from the discovery of subterraneous waters; while rivers would convey, in their tranquil parts, the idea of a level; in their reflections, that of a mirror; and in their currents, that of a moving and propelling power. The sea would suggest, by its agitated waves breaking upon hollow rocks, the idea of those spouting waters and cascades with which

our gardens are ornamented. I have seen, on the borders of Ascension Island, the waves strike the lower part of the porous and projecting beds of lava, pierce through the large interstices, and form, round that volcanic isle, a long display of foam, of jets, and cascades. It was on the sea-side that man first discovered the use of mother-of-pearl, and the rich dye of purple; that he first conceived the idea of nets from the interwoven grass; the notion of wheels, mills, and carriages, from the urchin rolling on its prickles; the idea of the grater, the saw, the stair-case, the helmet, the buckler, the lance, and every kind of armour, from the shells of *crustacea*; and even the modern invention of gunpowder may be conjectured to have been suggested by the sulphur and nitre of volcanoes. It was on the borders of the main that man invented the canoe, the boat, the schooner, the galley, the frigate, in imitation of the shapes, and even the names of shells, fish, and amphibious birds. We, who in an age of advanced civilization are little accustomed to trace inventions to their origin, may imagine that these notions are chimerical, or far-fetched; but we ought to fix our minds on the total blank of science in the case of our early ancestors, and we shall have less difficulty in believing that there exists nothing in human art, of which the model

has not been taken from nature, and the form of which is not to be found on the border of the waters.

It is there that the aquatic kingdom, combining its operations with those of the sun and air, unites the most perfect specimens of mineral, vegetable, and animal productions, such as golden sand, amber, pearls, or coral, and presents them as a homage to man. In all these gifts we trace, directly or indirectly, the beneficial operation of water. Rain brings fertility to our land, the spring supplies us with water for washing; the river facilitates the communication between district and district; the sea between nation and nation; and the ocean between mankind at large. A river, said Pascal, is a moving road, and those streams and seas, which appear at first intended to separate mankind for ever, are found the most effectual means of multiplying their communications. Let the land be shared out in private property, but let water remain open for the common benefit of all; not only seas, but rivers, rivulets, and even springs.

A great deal is said in praise of journeys to the Alps and Pyrenees: these have no doubt both their pleasure and their utility; but I am of opinion that excursions along the sea-coast are much more interesting. A view taken from the

summit of a lofty mountain is called familiarly a bird's-eye view; but I should call prospects from the bottom of vallies the proper view for the human eye. In the former, you see every object fall one after another until the whole is terminated by the ground; in the latter, you see them rise successively until they are crowned by the sky. Above all, it is on the borders of the ocean that the harmonies of the different powers of nature appear to be concentrated. It is there that we find displayed, on an horizon on a level with our eyes, the magnificent sight of the rising and setting of the sun, of the meteors of the air, of the flux and reflux of the tide, of the influx of vast rivers, and of mountains made rugged by the waves which dash against their sides and display their mineral contents.. It is there, likewise, that we contemplate the vegetables and animals of rivers, of the sea, and of the land; it is there that we see, in well-frequented harbours, the arrival of vessels from every nation. It is not on the summit of the mountain, but on the sea-shore; not in the gallery, but in the lower part of the amphitheatre, that the perspective, the decorations, and the drama of the works of nature are seen to greatest advantage.

The milk and the healing herbs of Switzerland are much famed, and I have certainly no

wish to detract from the confidence put in such innocent things; but the vegetable products and the cattle of the maritime provinces of Bretagne, Normandy, and Holland, possess equally beneficial qualities. It is from the borders of the sea, and not from the interior of the land, that we have derived our vegetable riches. It was at the base of Ætna, not on its icy summit, that Sicily produced both the stately chesnut loaded with fruit, and the comparatively humble corn plant. It was from the islands of the Archipelago, not from mount Ida, that most of our fruit-trees were derived. The walnut, the fig, the pear, the olive, the coffee, the cacao, the cotton and indigo plants, and sugar-cane, grow on the shores and islands of America, not on the back of the Cordilleras. Pepper, nutmeg, and cloves, are produced on the borders of the Molucca islands, not on the peaks of Java. Finally, do you desire to see glaciers like those of the Alps on the seashore? Its counter-currents will lead you in summer to the foot of the icy mass of the north pole, which even in that season presents an awful and magnificent appearance.

Had fortune permitted, I should have undertaken a voyage round Europe, and perhaps around the world, that would have been less fatiguing, more agreeable, and more useful, than

that which is so frequently performed in the mountains of Switzerland. I should have preferred coasting along in a swift-sailing boat, with lateen sail and a few mattresses. After taking care to provide a bark of sufficient accommodation for my family, I should have embarked them along with two seamen and their wives. In such a progress every object would prove a fund of instruction or of pleasure. The cliffs open their sides to the mineralogical investigator, and display at their bases an endless variety of pebbles rolled thither by rivers and currents. Were plants a favourite object, I could gather on the strand specimens of the most distant countries brought hither by the waves. Even the seeds of Jamaica are said to be brought in winter to the shores of the Orkneys, and why should not those of the Orkneys be conveyed in summer to the coast of France? Every step in our progress would have opened to me a new leaf in the book of nature, and have discovered a new landscape. On one part I should have seen on a shoal covered with sea-calves, fire-coloured flamingoes, aigrettes, pelicans, and other birds, the travellers of the torrid zone; in another part, in the midst of downs, I might perceive the ruins of a monument, on the top of which the stork builds its nest. Farther off I should perceive the mouth

of a river bordered with willows; I would ascend its stream in the midst of meadows and cultivated land, and contemplate at the end of the horizon the turrets of a city. Did a forest rise in the middle of an island, I would go and rest under its majestic shade. When the halcyon skimming the waves, and the sea-lark by its cries, announced the approach of a tempest or of nightfall, we should have obeyed the signal, and run our bark on the strand, choosing for our place of stoppage the trunk of an old tree, or the back of a rock at the influx of a stream. An interval might be passed by the male part of our little company in fishing or hunting, while the females lighted the fire and cooked the victuals; all would meet again on board the bark, sheltered by its sail from rain, cold, and wind.

Next morning we resume our course, if the dawn promises a fine day. We start without paying either post-horses, innkeepers, tolls, or turnpikes; we have no occasion to produce either passport or certificate; we avoid civil dissensions,—the wars which shed the blood of nations, and the still more cruel calamities which disturb mankind in the bosom of peace. It was in this simple manner that the primitive inhabitants of the coast of Asia travelled when they peopled America and the Fortunate Islands of

the South Sea. It was thus that liberty and comfort were preserved amidst their wandering tribes; it is thus, simple Patagonians, that you live, despised by proud Europeans; but, I charge you, do not envy our lot. The Apeninnes, the Alps, the Cordilleras, are subjugated by European sway, but the cliffs of Cape Horn will remain free. We are bending under the complexity and insufficiency of our laws, while you know only the laws of nature; we look to a long futurity in our vain sehemes, while you enjoy life as you receive it from day to day. For you life is only an innocent voyage, which conducts you to the abode of your ancestors. You support it without crimes, you pass it without remorse, and you quit it without regret.

Aquatic Harmonies of Children; or the History of a Rivulet.

I SHALL here suppose myself a teacher. To give my pupils the elementary notions of the harmonies of water, I should take them to the country in a rainy day, and should say to them, "My boys, let us follow the course of the stream which comes down from that wood-covered hill, and trace it to its source. It rains, but what signifies rain to us? We ought to accustom ourselves from our earliest years to brave the elements, and particularly water; for it rains in our climate more than half the year. A soldier, a sailor, a country labourer, a traveller, a mechanic, frequently expose themselves to rain for the sake of profit; would you dread it when your object is to get information? Rain is a kind of bath, not hurtful so long as we are in movement, and only to be feared when our perspiration is stopped by an interruption of exercise. It should thus be made light of by boys, although the case is very different with girls, who are destined by nature to watch over the interior of a house.— The weakness of their sex should exempt them from fatigues that men ought not to dread. It will be their part one day to provide a com-

fortable home for their husbands and sons when returning from labour; let them therefore make a beginning in this way at present, by preparing dry clothing and warm diet to their brothers when returning from a walk of some extent. Their brothers will amuse them by an account of their progress, and if the females do not receive much instruction in return for their good offices, they will receive at least the thanks of their young relations.

Let us proceed in our way, and endeavour to discover whence this rivulet draws its source; let us, as we follow its winding course, observe the harmonies of the powers of Nature with water under the different relations of evaporation, fluidity, and freezing. To begin with the effects of the solar rays. Observe these mists, which seem fixed on the distant summits of the mountains; it is they which supply the water which flows at your feet. But whence do they derive it themselves? There was a time when men, flying from each other on account of their predatory disposition, and yielding obedience only to the terrors of superstition, imagined these streams and rivers to be divinities pouring forth water by urns, and inhabiting the summits of mountains; while the mists attracted thither formed the clouds with which they veiled themselves from mortal eyes.

The storms engendered there appeared to them to be the thunder and lightning with which they were armed. It was thus that the Greeks placed Jupiter on the top of Olympus; and that the Arcadians, who had taken refuge in Italy, insisted that they had seen that deity with his ægis on the woody top of the Capitol, as the good Evander relates to Æneas:

> Hoc nemus, hunc, inquit, frondoso vertice collem,
> Quis deus? incertum est, habitat deus: Arcades ipsum
> Credunt se vidisse Jovem, quum sæpe nigrantem
> Ægida concuteret dextra, nimbosque cieret.
>
> *Æneid, Book VIII.*

> Some god they knew—what god, they could not tell—
> Did there amidst the sacred horror dwell.
> The Arcadians thought him Jove; and said they saw
> The mighty Thunderer with majestic awe,
> Who shook his shield, and dealt his bolts around,
> And scattered tempests on the teeming ground.

But when men were drawn together by their wants, and made their observations in common, they discovered that mists were raised from the ocean by the sun's heat; that the air received and carried them along; that the earth attracted them by the electric summits of its mountains; and that from thence they dissolved in rain, so as to fill the beds of rivers, and spread fecundity over the country. Then, instead of trembling before

imaginary and harsh deities, in whose name avaricious priests often extracted cruel sacrifices, they adored in common the Father of the Universe, whose elements were his ministers, and who made himself manifest to man only by blessings. Let us next consider some of the chief qualities of water; it reflects on its surface, and refracts in its vapours. By refraction I mean its faculty of breaking the rays of light, and of augmenting the opening of the angles of bodies perceived through it, so as to increase their apparent size. It is thus that the rising sun, when seen through a mist, appears twice as large as usual. It is likewise by refraction that a stick plunged in water seems to be broken, and of a larger diameter than the part that is out of the water. When vapours are opposed to the solar rays and united in drops of rain, they both refract and reflect light, which then becomes decomposed in colours. Such is the cause of the rainbow, of which you perceive some traces towards the west.

Reflection without refraction returns light in a pure state, and it is on that account that the rivulet at the bottom of yonder valley seems resplendent like a mirror.

Reflection (in French *reflèt*) is the property which water has of representing surrounding objects as if they were enclosed within it. The

study of natural philosophy will explain to you some day the laws of this wonderful mechanism. Water reflects light from its surface on the bodies which adjoin it, and their forms from within. Had it reflected them like light, the shape of the trees and lands on its banks would have been apparent on its surface, so that this repetition of the same objects on the same planes would have destroyed the unity of the sites of Nature; imaginary objects would have been confounded with real ones. Birds would hover in vain around an imaginary willow to build their nests there; and the ox would run against a real willow by mistaking it for its image. Nature has indeed employed double harmonies in most situations; but she has transported them from one kingdom to another to avoid confusion. If a rivulet reflects at the bottom of its bed the eminence on its banks, the eminence sometimes re-echoes from its summit the murmur of the rivulet. The reflections of the water are to the earth what the echoes of the earth are to air; Nature has diffused the charm of moral harmonies even unto physical objects. Water is indebted, for the qualities which appear peculiar to it, to a combination of harmonies. Its vapours, its rain, its fluidity, its refraction, its reflection, its snow, its hail, its ice, result from the presence or absence of the sun. Its ascent in the atmosphere is owing to

the spongy nature and the comparative weight of air; its motion to the course of the winds; and its equilibrium with itself, or its level throughout the earth, is owing, as well as its currents, to the attraction of the globe. Earth attracts water even to its smallest and hardest particles. Not only does it imbibe it as a sponge when in a state of dust; but the driest stone will be found to contain a portion of it. Observe that lime-kiln on the top of the hill; a thick cloud of smoke comes out of it, although it is only heated by brush-wood and filled with stones. If you put a lime-stone on hot coals you will see it smoke; it exhales the vapours of the water contained in it, which, by their extreme tenuity, penetrate the most compact bodies. The effect of this may be seen in a small pebble, which is highly valued on account of its property of imbibing water very soon. Naturally it is opaque, but if put in water it admits it so as to become semi-transparent. It is known by the name of *oculus mundi;* a name apparently misplaced in regard to so small an object, for it is hardly larger than a pea, and resembles a fragment of the outside of a flint, with which it is said by some naturalists to have an affinity. Some specimens of this pebble are said to have been sold for 100 pounds on account of their curious quality. For my part, I consider lime-stone beyond comparison more cu-

rious and more useful; for after having contained water, which, when put into the fire, it renders visible by its smoke, it imbibes fire as it shows on being put again into water. It is, moreover, applicable to a variety of uses.

To return to our little rivulet. One of the chief objects of attention is its current; this it owes to the central attraction of the earth, the earth drawing water to its centre when in a state of fluidity, and to the summits of its mountains when in a state of evaporation. The earth may be called a loadstone with several poles; I can point out three proceeding from the same centre; the poles of the mountains, the two poles of the globe, and the central pole, which is the seat of attraction. Observe that mist which covers the summit of the hill. It seems fixed there, and is joined by more mist coming to the same spot from different parts of the valley. In mountainous countries you see the pyramids of rocks which crown them surrounded by a cloudy covering. If the mountains are very high, as in Switzerland, large masses of snow and ice are formed and last all the year through. These glaciers are sometimes thirty leagues in length, and five or six leagues in breadth, extending to a height of five or six hundred feet. They are the icy castles of the Rhine, the Rhone, and several other rivers. The glaciers of the Cordilleras in America are

much more extensive and more lofty; hence they give rise to mighty rivers, and particularly to that of the Amazons, which has a course of fifteen hundred leagues, and is above a hundred leagues wide at the mouth. But even the glaciers of the Cordilleras are nothing in comparison with those of the poles, which are supposed to have in winter a circumference of several thousand leagues, and from which the ocean itself derives its grand supply. The current of all these waters is directed to the centre of the earth, the common point of attraction of all bodies. The various attractions of the mountains, the poles, and the centre, extend perhaps to other bodies, as far at least as we can judge by the compass; for if the latter directs its point generally towards the north pole, it varies that direction in the neighbourhood of a number of mountains, and it has a tendency, likewise, to incline towards the centre of the earth. It is indeed very probable that these different attractions are caused by iron mines; the summits of the mountains which attract clouds being in general ferruginous. We are likewise to observe that the central attraction of the earth acts on all bodies without exception, inasmuch as it is the cause of their gravity. Whatever be the scientific explanation of this phenomenon, certain it is that the general tendency of fluids towards the centre of the earth is

the cause of forming, on one side, the level of lakes, and on the other the current of rivers. It is from this tendency that the water-level takes its origin. The level of water being nothing but the equilibrium of all its parts round the centre of the earth, the consequence is that the surface of a lake and that of the sea are spherical. The curve hence arising, as I have already remarked, is extremely visible in the open sea, since it has the effect of concealing from the eye the hull of a ship at the distance of four miles, and the highest part of its mast at that of twelve or fifteen. It follows that the surface of the earth, which often presents segments of a circle in almost all its circumference, has been in a former age in a state of fluidity, and has been levelled by the operation of water.

So much for that proportion of water which is on a level and in a state of repose; but that proportion is small compared with the whole. From the spring to the ocean, almost the whole of the watery world is in a state of circulation. The rain which is now falling feeds a spring in the spot before you; the spring forms the rivulet; the rivulet throws itself into the river; the river into the sea; and the sea into the Atlantic Ocean, the vapours of which bring us a supply of rain. A spring in general draws its waters from a rock;

a rivulet from a hill; a river from a mountain; a sea from the adjacent tracks of continent; and the ocean from the ice covering the poles of the world.

This rivulet, feeble as it is, may give you an idea of the ocean and of its bed, something in the way that a small plant may give you an idea of a large tree. You can discover here banks, strands, straits, promontories, capes, bays, sand-banks, shallows, islands, peninsulas, confluxes, and even marshes. If the earth has substances attractive of water, it has others of a contrary nature; such in general are the different kinds of clay. Of these the most remarkable are two sorts of potter's clay, one kind of which (in French *glaise*) is greyish, tough, compact, and soft to the touch; while the other (*argile*) differs from it only in its ferruginous particles, which show themselves in baking by their red colour. You observe beds of these different kinds of earth in the banks of the rivulet, where they are broken by the stream. Observe the water dripping, or running, from the upper part of these banks like so many threads. Rain-water attracted by rocks penetrates the vegetable earth as well as the layers of sand, where it undergoes a purifying process; but it would be lost in the interior of the ground were it not stopped by beds of clay, placed there

by Nature at different degrees of depth. It is on these beds that repose the stores of subterranean water which furnish springs to our rivers, and water to our wells. Such springs are often found on the sea-side, and are particularly observable at low water; for it is above all on the sea-coast that the various beds of earth become visible. This observation may be of considerable importance to a man who has been shipwrecked even on a barren sand-bank. He may find a supply of fresh water on the very borders of the sea by digging a foot in depth at ebb tide. It is, I believe, to subterranean water, stopped in its downward progress by layers of clay and sometimes of rocks, that we are to ascribe those emissions from the earth which during night bedew plants in the burning heats of summer. Without such admirable precaution a portion of the vegetable world would be exposed to perish; since there are many spots on the earth where the rain falls only during a particular season.

We are now arrived at the source of the rivulet. Observe it come out murmuring from the cleft of this rock covered with adiantum and scolopendras. Its waters are collected in a small basin bordered with reeds and rushes; around are poplars and willows; at a greater distance on the neighbouring heights stand the lofty beech

and chesnut. The water you observe flows from all parts of the rock; this is because it attracts the mist from all parts; in a season of rain and thaw you may perceive similar effects in the inside of houses, on stones and on panes of glass, which are then humid because they attract vapours. The source of this rivulet comes from a spot still higher than the one we are now standing on. It is formed there by vapours collected by other rocks into filaments of water, which, after penetrating the surface of the earth, unite on a rocky bed, come out by this opening, and are collected in this basin. Without these different reservoirs both within and without, the water falling in the shape of rain would run off incessantly, and rivulets would be left dry whenever the wind was too low to carry a supply of clouds to the top of the hills. You will find that the same holds in regard to the source of all regular currents; a torrent is a work of chance, a rivulet is a work of Nature. There are reservoirs on all the heights which attract water, and at the top of every regular current. There is often merely a basin at the source of a rivulet, and a pond or marsh at the source of a river; but a large river has in general an icy mountain for its original storehouse, with a lake at its foot to receive the melted fluid; and the ocean has in

our hemisphere one of its poles covered with an immense cupola of ice, with inlets around which receive its waters, and distribute them over the whole globe.

But how, you will say, can a cause purely mechanical be productive of such well-combined results? The hand which draws characters is unconscious of their thoughts; intelligence is confined to that invisible Spirit which regulates them and inspires their actions. You see that an all-wise Providence has collected and combined elements for the wants of vegetables and animals; that Providence is beyond the observation of our corporeal senses; but it is rendered manifest by its blessings: *Mens agitat molem.* How great one day will be your surprise when, on studying the harmonies of trees with water, you shall see those of lofty mountains and barren spots attract vapours, and collect them by means of leaves in the shape of pencils, tongues, cups, and scoops, as takes place in the pine, the elm, and the chesnut; while those which grow in the bosom of water, and stand consequently in no need of being bedewed, like the nymphæa, reeds, rushes, or samphire, repel the aquatic supply, and have leaves which can neither become wetted nor serve as aqueducts. How great will be your delight when you shall discover that

the birds of the mountains take a pleasure in wetting their plumes with rain or spring water, while aquatic birds plunge into the waves without imbibing any part of the moisture into their plumage! How much useful information will you receive from observing the different methods in which the tenants of the deep skim along its surface! What Vaucanson among you is destined to construct some day, in imitation of the shape of the fish, a vessel which may rival it in swiftness? Nature, I know, does not require you to give yourselves up to a laborious research for the purpose of enlightening your mind and touching your heart. Her harmonies make manifest, without any painful study, the infinite intelligence of her Author, and his blessings towards his creatures; but in inviting you to extend your knowledge and your virtue, I point you out Nature as the only source of true art or science. It is above all in her bosom that the naturalist ought to search for general principles. Natural philosophy derives her creed only from experiments, and her morality from the power of machinery. May none of you ever discover the unhappy ingenuity of inventing such as might be rendered instruments of cruelty to animals, or of destruction to your own species.

We must admire the wisdom of Providence in

enabling so delicate a frame as the human body to support all the vicissitudes of the elements, and to live in every climate. Habit is for man a second nature, not by creating to him a second existence, but because in consequence of harmonizing with Nature in a variety of ways, he becomes susceptible of a variety of habits. In this his situation is singular and distinct from that of all other living beings. It is chiefly for the use of man that Nature has distributed water in a fit state for drinking in every part of the earth; she has deposited it in snow and ice in the frozen zones; in subterraneous layers in the burning sands of the torrid zone; she scatters it in rain over the vast surface of the sea, and she makes it flow in rivulets, streams, and rivers throughout the continents. The elephant of the torrid zone, who can drink only by sucking in water with his trunk, would die of thirst among the snows of Lapland, were he not to die of cold. On the other hand the rein-deer of the frozen zone, accustomed to browse on moss and snow, would die of heat, and perhaps of thirst, on the banks of the tepid waters of the Senegal and the Gambia. Man alone finds water proper for his use in all directions. Even the remote seas towards the north or south pole afford him, by their floating ice, a resource of this description, the process of

freezing removing the salt from the sea-water. Chemists imitate this result by freezing water impregnated with salt, and extracting from it crystals of fresh water. As for me, my object is to admire the result of the laws of Nature in favour of man. Navigators may perhaps discover the means of extracting relief from those masses of ice which sometimes float out of the limits of the icy zone; and it seems not impossible that those illusory shoals of the colour of beryl, which occur so frequently in the seas of warm climates, and which so many mariners have noted on their journals, will be found to be the remains of submerged masses of ice.—It is a singular fact that it is not impracticable to accustom ourselves by dint of time to drink salt water. Dutch navigators, among others Schouten, declare that they met in the South Sea, at the distance of more than three hundred leagues from any land, canoes with savages, whose wives gave salt water to their children to drink without any apparent injury, a consequence, no doubt, of early habit. In my passage out to the Isle of France, some of the ship's officers having stowed casks of brandy instead of water in the part of the hold appropriated to water, with the view of selling the brandy abroad, we were reduced by this trick to a scarcity of fresh water, and obliged to confine our-

selves to an allowance of a bottle a day. Some of the seamen, labouring under the pressure of thirst, endeavoured to allay it by drinking salt water; but it by no means agreed with them, and was productive even of vomiting.

But see! the accumulated clouds are proceeding slowly through the air; the sun has raised them above the ocean, and the south wind is driving them towards the north pole to soften the rigours of winter, and renovate on their way the sources of seas and rivers. If this atmospheric ocean, when passing over our heads, were to fall in masses, it would overthrow every landmark on the ground; but it runs from the sky in long threads, as if poured out of a watering pot. The fields imbibe it, the plants receive it in their growing leaves, and the birds on their plumes. You now see Nature in the infancy of the year; already the rain washes the surface of the ground; the discoloured rivulets murmur along the slope of the hills, and carry along with them fragments of earth, stones, vegetables, and even animals which have perished by cold. These they carry into larger streams; the streams again into rivers; the rivers into seas, and the currents display them along the shore. There the waves, beating incessantly against the shore, reduce the hardest bodies into sand; and the fires of volcanoes, disseminated

on their banks, consume the oil, the sulphur, the salt, and fragments of the animal kingdom, restoring the whole to elementary principles. The ocean is both the tomb and the cradle of the globe. Ignorant people have made pilgrimages to the summit of mountains, under the notion that they were thus getting nearer to heaven; the enlightened part of mankind should make such pilgrimages to the sea-side, that they might have a view of the first agents of Nature and of society.

At the same time do not desire to follow the example of those navigators who have made the circuit of the world; they only who have performed voyages for the sake of benefiting their species deserve to be accounted objects of envy. How many have traversed distant regions to lay them waste! How many others have aimed at nothing but the profits of trade! But how should you be qualified to appreciate or admire the works of Nature in a foreign land, if you have not a previous knowledge of her wonders in your own? God has made two lots of the gifts distributed to man; he has placed on one hand fortune and danger, glory and envy; on the other, mediocrity and comfort, obscurity and repose. Sometimes a youth, led astray by deceitful accounts of travels, quits his parents, embarks, and believes that

he shall be happier in another climate than in his own. Oh! how often will he sigh after the paternal roof in the midst of stormy seas! how often will he regret the humble violet of our springs, when under the shade of the palm-tree of the torrid zone! Happy he who prefers the banks of his own rivulet to the borders of the ocean; who, full of gratitude for his parents, seeks no other fortune than that of comforting them by his labour; and no other glory than that of making passion subservient to reason.

But we are now drawing near to the town, and it is time for us to part: your affectionate brothers and sisters are waiting for you; go and show them how fond you are of your home, and how eager for instruction. In giving you an idea of the harmony of waters, I have not made you run over a cabinet of natural history filled with frail, passive, and dead machines; I have led you to the midst of an active and lively scene of Nature, amidst woods, winds, and rocks.

BOOK IV.

TERRESTRIAL HARMONIES.

THE ground, though still in the infancy of the year, allows us to examine its surface and its strata. The sun has carried off a portion of the snow, which covered it like a garment, and defended it from the rigour of winter; only a few insulated spots are now to be seen on the summits of the mountains. The brown colour of the soil appears in all directions, and the rugged part of the ravines discovers various beds of fossils mixed with primroses and violets; vegetable life announces itself around; the blasts of the south, lulled asleep in their dark caverns, surprised to see the light suddenly come in, awake and rise in fury. These fierce sons of winter and of night overturn the masses of ice which they had raised towards the sources of the ocean, and rush, with loud noise, towards the orb of day. In their passage they convulse the seas, shake the forests, scatter thick mists in the air, and prepare for our

hemisphere, even by their tempests, a new morn and a new life.

O thou whom antiquity called the mother of the Gods, Cybele,—Earth, which supportest my fugitive existence, inspire me, at the bottom of some obscure grotto, with the same spirit which disclosed future events to thy ancient oracles! It is for thee that the sun shines, the winds blow, the rivers and the seas keep in motion. It is thou whom the Hours, the Zephyrs, and the Nereids, deck with crowns of light, with garlands of flowers, and with azure girdles; it is on thee that all who breathe suspend the lamp of life. All unite around thee, the mother of living beings; elements, vegetables, animals, all adhere to thy maternal bosom as thy children. The orb of night herself surrounds thee incessantly with her pale light; thou rollest continually around the orb of day, warming thy innumerable breasts successively with his rays. Thou alone, in the midst of these great movements, affordest to inconstant men an example of constancy. It is neither in fields of light, nor in those of air and water, but in thy sides, that they find the means of support and eventual rest from their labours, O Earth, the cradle and the tomb of all beings, before the time comes for depositing my ashes in thy bosom, disclose to me thy riches, the beauty

of thy valleys, and the grandeur of thy mountains whence flow so many streams; until my soul, disentangled from the weight of my body, takes its flight towards that upper region from whence thou thyself derivest immortal life.

Our artificial life is founded only on natural laws; it is to these laws of attraction, which regulate the planets, that our rivers owe their slopes which make them roll along the surface of the ground; that our seas owe their level; that our rocks, our edifices, and even our bodies, owe their balance. Is it not a gratifying discovery to learn that the laws of Nature are always active in the midst of deserts and of darkness? But he who sees only attraction in the universe may be said to see nothing in a palace beyond the square and the level which have raised its columns. The mechanic laws of Nature are directed by an intelligent power; the ink which flows from my pen on the paper to express these reflections, obeys blindly the central attraction of the earth; the pen, out of which the ink flows, yields in like manner to the horizontal direction which my hand gives it from right to left; my hand, although alive and organized, knows no more what it writes than the ink, the pen, or the paper; but the head which directs these different instruments comprehends the whole, and the heart which

receives the impression knows how to feel it. Thus, if I may be permitted to compare celestial objects to those of our humble sphere, the Deity may be said to make use of the sun as of a hand, and of his rays as of a pen or pencil. With these he is pleased to trace on the earth, by means of blind and insensible elements, intellectual characters, the thoughts conveyed by which are objects of sensation to man, who is in some degree the heart of Nature.

But man, although impressed with admiration at the sight of the great book of Nature, can succeed in reading it only by the aid of his fellow-creatures. Let us suppose, by way of a ludicrous illustration, an ant in the Pantheon of ancient Rome; she would naturally take the inscriptions hollowed out in the stones for vallies, and the bas-reliefs of the figures for mountains; wholly occupied with her own little wants, she would be unconscious of inhabiting one of the principal monuments of the Roman republic, built by a creature of a different description for the abode of the Gods. The insect would look on this vast edifice, with its fine cupola, as merely a work of chance; yet, could she communicate with other tribes of ants dispersed around, she would learn that the building is of a circular figure; that it contains entrances in correspondence with a large

city; and she might perhaps arrive at last at the notion that it was built with as much skill as her own ant-hill. But Nature has given even to the petty republics of insects a kind of intolerance which confines their views to their own tribe, lest in the case of general co-operation they might destroy works of some consequence to man.

Now human society would be little farther advanced than those of these humble insects, if like them they led an insulated life. A solitary man would see nothing on the globe but precipices in valleys, and rugged inequalities in mountains. An islander would believe, as in ancient days, that the sun rises and sets in the sea; a geometrician himself would find in that luminary nothing but a focus attracting the planets around him, and which, spreading itself among all bodies in proportion to their masses, pushes the one towards the other without bringing them into contact. He would be aware that rivers owe their currents to that central attraction which makes their waters run towards the lower part of the earth; but he could not consider their supply of water inexhaustible, unless instructed by the naturalist that the sun himself raised the vapours of the seas to the summits of mountains, and that to the law of central attraction of the earth, must be added that of the aërial evapora-

tion of the ocean, to afford a complete explanation of the permanency of the course of rivers.

As for me, I am only an atom, whom the blasts of adversity have cast successively on various spots of the earth, amidst different tribes of my fellow-men. I have endeavoured to approximate their detached ideas, and to arrive at the conclusion that the earth was a monument of the wisdom of the Divinity; that all its parts were in correspondence; that its valleys and its mountains were characters and figures expressive of thought; that its entire globe was a pantheon, not constructed by human hands for the abode of the Divinity, but created by the Divinity to serve as a scene for the display of human virtue. The extent of our knowledge and of our comfort will be found dependant on our union and co-operation.

Of Mountains.

We should begin by obtaining a distinct idea of the outward form of the earth, particularly of mountains and valleys. We must not take for granted that their shape depends on the mere course of water, and that they have all, as Buffon imagines, re-entering and salient angles in correspondence with each other. To be convinced of the contrary, we have only to cast our eyes on a good chart of the mountains of Dauphiny, or even of some of our islands in America; we shall soon perceive a great number without alternate angles. Nor must we, on the other hand, imagine that they all derive their origin from fire, because some of them are volcanic. Nothing is more dangerous than the error into which our present mode of education naturally leads us, of assigning to Nature the laws suggested by our feeble progress in art and science, and of drawing a general conclusion from a particular case. Such a method would prevent us from forming any just idea of the earth, even if our geography, which divides it into so many political compartments, had not thrown an additional obstacle in the way. We shall proceed then on the plan of referring mountains, as well as their fossils, to the different

powers of nature, and to their physical and social harmonies, of which we shall find at least sixteen different kinds. There are solar and lunar mountains, some of which, like those of Finland, are so arranged as to reverberate the rays of heat; while others are so shaped, as to produce, like some mountains in Ethiopia, an effect like that of a parasol. Some may, without exaggeration, be called hyemal, from carrying a perpetual winter on their summits; while others are volcanic, and emit fire from their sides. Of the mountains called hyemal, some have the beds of their summits oblique, and raised towards the sky like the leaves of an artichoke, so as to retain a mass of glaciers; this is the case both with the Alps and Cordilleras. Others again have a more direct slope, and admit of having their icy covering sooner melted; this holds in regard to the mountains of Greenland and Spitzbergen. All mountains of these different descriptions are adapted to the positive or negative operation of the sun. I class volcanic mountains under these, although they belong in some measure to water, which they have a tendency to purify; but they owe originally their combustion to the sun as the source of all fire and heat. Some mountains may be called aërial, in particular those which are known by the name of Eolian, and send forth

winds in the way already explained; while others, called Anti-eolian, serve as obstacles to the winds. There are likewise aquatic mountains; some, called hydraulic, are at the source of rivers, and attract incessantly the vapours of the atmosphere by their peaks; others are littoral, and form a bulwark against the waters by their bases. Of the latter I distinguish two kinds, littoral on the sea coast, and littoral on the banks of rivers. It is among the last that we find mountains, or rather hills, with salient and re-entering angles corresponding to each other. There are some mountains of such magnitude as to be considered among the most important parts of the mechanism of the globe; such are the extensive beds of granite in the polar regions on a level, in their lower parts, with the sea, and the peaks of the same materials, which, like those of the Alps and Pyrenees, rise by chains in the interior of continents, to the extraordinary height of ten or twelve thousand feet, and seem to approach the level of the poles. Even the plains of the globe are uneven; some being in gentle and insensible slopes, over which rivulets hold their winding way; while others are amphitheatrical, and serve for the course of large and rapid rivers.

Terrestrial Harmonies of the Sun and Moon.

MOUNTAINS, when viewed in relation to the sun, possess a negative or positive, a passive or active operation. By parasol mountains, I mean those which protect vegetables and animals from the excess of summer heat, and are so constructed as to afford them a great extent of shade. These mountains are, in general, formed of very extensive strata, and are steep in all directions, so that it is with difficulty that a slope is found to ascend their sides. The adjacent valleys resemble precipices of a surprising depth. Such a shape admits of the vegetables of our temperate climates growing even under the line, and in districts of the interior of continents which are not, like the islands of the torrid zone, refreshed by sea breezes. Plants grow on the surface of these elevated strata, and enjoy the freshness of an upper atmosphere without experiencing that reflection of heat from the neighbouring slopes, which takes place in many mountains in our temperate climates. Again, the plants cultivated in these deep valleys are covered with shade during a great part of the day. The colour of their lateral rocks is in general brown or black, and con-

tributes, no doubt, to weaken the reflection of the solar rays.

It is remarkable that mountains, thus calculated to afford protection from heat, increase in number as we approach a hot climate. Some of them are to be found in Italy; several in the Grecian islands, and a larger number in India. It was perhaps in consequence of the mountains being so steep in these countries, that the punishment of throwing criminals from their top was adopted, a punishment which in flat countries like Holland or Poland could not be carried into effect without previously digging wells. Steep and rugged mountains are common between the tropics, in the West Indies, the Moluccas, Japan, and in the south of China, where they produce a very agreeable effect on the landscape. I have seen several of them in the Isle of France, one in particular, called the mountain of the Corps-de-Garde, from which Commerçon, the botanist, apprehended that he should never be able to get down. Having been conducted thither by an inhabitant of the neighbourhood, who offered to continue with him during his botanizing excursion, Commerçon insisted on his going home, assuring him that he should be able to find his way down alone. On finishing his scientific observations, he set out on his return, but although the moun-

tain-top does not extend a mile and a half in length, he found it impracticable to discover the spot where he had come up, and he sought just as fruitlessly an issue in another direction. Being obliged to pass the night in this elevated track, he contrived to make a supper out of a species of peas which he found here in very limited quantity. Next day his efforts to descend were as ineffectual as before, and he would probably have died of hunger, had not his guide, disquieted by his long absence, returned to find him. This circumstance took place during my stay at the Isle of France. It was on the same mountain that an officer in the service of our East India Company presumed to raise the standard of revolt some years before, at the head of a few followers. He was perfectly right in calculating that his position on such a spot could not be forced, but he had not taken into the account that he himself would find it impracticable to get out of it. He was obliged to surrender at discretion, and as he had good friends and patrons, his conduct, highly improper as it was, was passed over as a juvenile imprudence.

The nearer we draw to the Line, the more frequent are mountains of the shape I have mentioned. There are a number of them in Arabia Petræa, but Ethiopia is in a manner covered with

them. Francisco Alvares, chaplain to the Portuguese, sent thither on an embassy in 1520, has given us the first and best description of this country with which I am acquainted, although Ludolf and other historians of Ethiopia do not think proper to make him many acknowledgements. Ethiopia, says Alvares, is full of mountains, which are steep in all directions, and of a surprising height; he adds, that he was near one of them which extended almost all the way to the Nile, and the circuit of which could hardly be made by a pedestrian in less than a fortnight. Its sides were steep as ramparts, and there were apparently only three approaches to this formidable elevation. On this mountain, there are others of smaller size, but of the same form, with valleys between, which from their spongy and boggy nature are impassable. It is there that the Ethiopian monarch is said to confine his children and his posterity at large. The sides of these extensive strata are covered, according to the report of this traveller, with clouds; while the rivers descending from them fill their channels very soon after the occurrence of a storm, and send on their waters into the valleys with the rapidity of a torrent. All that stands in their way is overwhelmed; and the ill-fated traveller, who has sought repose and freshness in their

dry beds, is sometimes the victim of his imprudence.

The formation of these enormous shelves of rock of a single piece, in the bottom of which the Ethiopians excavate complete churches, and the perpendicular sides of which have two or three slopes for the purpose of ascent, is not to be accounted for by the wearing away of land by water, and still less by earthquakes. They are generally separated from each other by valleys as broad above as at the bottom; some of them are entirely insulated like the one already mentioned as serving for a state prison, or like Mount Tabor in Judæa. Whatever be their origin, they are of great use for agricultural purposes. Their valleys, moreover, are covered with rocks and detached pieces of stones, a circumstance which some conjecture to have been the cause of introducing the practice of stoning criminals in the countries where they were, as I have just mentioned, in the habit of precipitating them from a rock. It was, no doubt, in countries abounding with stones that slings were invented, and adopted as an instrument of war; affording one more example of the disposition of mankind to turn to purposes of mutual annoyance those gifts which Nature intended for the general good.

Stones lying on a level with the surface of the

earth are highly conducive in warm countries to the growth of plants, by affording shade and freshness to their seeds. Pliny relates that an agriculturist, in a quarter of Italy situated, I believe, in one of the openings into the Apennines, having cleared his field of stones, was completely disappointed in regard to the expected advantage, and was even obliged to bring back the stones to restore the field to its former degree of fertility. I can speak from personal experience in regard to the Isle of France, having seen the same thing happen in that warm climate. Stones scattered along the surface of the ground are equally common and equally useful in cold as in hot countries, although by producing directly contrary effects; that is, by reflecting heat on the south side, and affording shelter on the north. Finland is as much covered with rocks as Malta, Martinique, or the Isle of France. Rocks and stones are scarce towards the middle of the temperate zones, but they abound in the torrid and frigid zones. We have already expressed an opinion that the innumerable fragments of rocks scattered in those parts of the world owed their origin to the progressive operation of thaw; be this as it may, Nature makes them productive of great utility to men and animals. Blind elements are every where subordinate to a wise direction:

that attractive power, which puts them in motion, may be called an harmonious lyre, attuned by the hands of a divine artist.

Parasol mountains are found to contain metals of all kinds;—iron, copper, lead, and particularly gold, which seems to derive its origin from the torrid zone. The mountains in that zone are the largest of any in the world, and contain, in all probability, most of the minerals, vegetables, and animals, disseminated throughout the rest of the globe, along with many that are peculiar to it on account of the perpetual influence of the sun. Certain it is that diamonds are not to be found out of the limits of this zone. It seems that the living sphere of the orb of day fixes its light and its attractions among a multitude of magnificent crystallizations. By crystallization I mean the tendency which certain minerals have to unite at a common centre, according to directions which appear characteristic of their particular nature. Some are united in two pyramids with four faces, like diamonds and rubies; some with six, like oriental topazes and rock crystals; others with eight, like European topazes and schörls; with nine, like the tourmalin; with ten, like the feldt-spath; with twelve, twenty-four, and thirty-six faces, like garnets; and finally in radiating spheres, like pyrites.

All crystallizations of this description are in their highest beauty in the mountains of the torrid zone. It is likewise in its valleys and on its banks that we find the richest productions of the vegetable and animal kingdom, in spiceries, perfumes, ambers, birds, quadrupeds, and fishes. No zone possesses so large a variety of kinds peculiar to itself.

Although the sides of parasol mountains are steep, and without a covering of earth, Nature finds various means of clothing them with verdure. At one time she produces at their base creeping lianas, which form a kind of carpeting to a considerable height, at a greater height indeed than that of the loftiest trees: at another time she raises in the clefts of their summits vegetables of a very opposite character, which hang their heads and wave at the impulse of the winds. Of this description is a kind utterly devoid of leaves, which I once found suspended on the sides of the rocks of the Isle of France, called the "thumb," at the top of the mountains which surround the Champ de Mars. It consisted of a number of boughs similar to the jessamine, thin and supple as twine; the one came forth from the other, and bore in the axillæ small flowers like roses, about the size of pinheads, and yellow like gold. They cast on the

paper, in which I had put up several boughs, a quantity of seminal dust, similar to flower of sulphur. I am not acquainted with the name of this plant. It is these parasol mountains, with their rich display of vegetable products, that give such a charm to the landscapes of China. They are seen sometimes to rise with hanging tops, and with drapery covered with verdure, on the banks of rivers which reflect their beautiful image. However steep their sides, there are still birds which frequent them, and which repair thither for the purpose of picking the nitre collected on them. It is to a rock of this description, barren, uninhabited, bare, situated in the midst of the sea, and apparently incapable of any eulogium, that Homer, who found means to cast embellishment on every thing, bestows the true and pleasant epithet, "beloved of doves." The dusky mountains of the Isle of France are frequented by the white birds of the tropics, which nestle there, and perhaps by the blue birds of passage, called in that quarter Dutch pigeons; but the most surprising of all is that there should be quadrupeds destined to live in ridges of such difficult access as the tops of these mountains. Alvarez says that in Ethiopia these lofty spots swarm with apes, which raise a shrill cry on seeing men of a foreign aspect or dress pass

near them; he even gives to one of these elevations the name of Ape Mountain, on account of the prodigious numbers of these animals on it. In the Isle of France, I have seen apes pass in long files along the sides of the steepest and loftiest rocks, upon so slender a cornice that one could scarcely perceive where they placed their feet; they looked indeed as if sculptured in relievo on the sides of the mountain. If we consider the whole make of an ape, his narrow sides, his long body, his hind legs higher than those before, and full of springs for skipping over precipices; his tail which, twining like a serpent, is so well adapted to take hold of bushes and to aid him in leaping; his paws or hands, the fingers of which take a grasp of the slightest point of a rock; the thickness of his hide in warm latitudes; his instinct in laying hold of stones, and of throwing them at the head of his enemies; the piercing cries by which he makes himself heard at a distance, and which he seems to take a pleasure in repeating to the echoes; all these circumstances tend to show that he is less formed for the forests of the torrid zone than for those steep mountains, the summit of which rise into the cold part of the atmosphere. We are thus enabled to see in what manner parasol mountains enter into the general circle of har-

mony, since Nature has provided both plants to adorn, and animals to inhabit them.

Such is the power of Nature that she finds means to extract different and even opposite effects from the same object, rendering a rock a shelter from heat in the south, and a reflector in the north. By a reverberating or reflecting mountain, I mean one which reflects the solar rays. These, although composed of stones like the parasol mountains, differ essentially from them in point of colour, shape, manner of aggregation, and mineral contents. Instead of being dusky, they are in general of a delicate colour, filled with shining particles of mica, as in Finland; covered with white moss, as in Lapland; or resplendent as silver, like those of Spitzbergen described by Martenz. Far from having their summits flattened like parasol mountains, they have them rounded like a pyramidical cup, or like the back of an ass, and without covering of any kind, the consequence of which is that the snow does not lie long on them. They have likewise at their foundations a quantity of fragments of rock, which serve as a shelter to vegetable products against the north wind, and reflect on them the solar rays. Mountains of this description are to be found in Finland, in Swedish and Russian Lapland, and in the islands in the

north part of the Baltic. On the other hand, the tract of continent situated to the north of that sea is covered with rocky mountains all the way to the borders of the Frozen Ocean. The countries southward of the Baltic consist of plains of great extent, and in general sandy, such as the *Steppes* of the Ukraine; and to the eastward those of Tartary. Tracts of land covered with rocks are to be found throughout the north of Siberia, and of China, all the way to Kamtschatka; nor are they less frequent in the same latitudes to the west; in Iceland, as described by Anderson; in the north of Scotland; in the Orkney and Shetland Islands; in America; in the islands and coasts of Hudson's Bay, as visited and described by Ellis; in those of the southern hemisphere, as Terra del Fuego, the Islands of Kerguelin, and even the southern Thule, discovered by Cook.

We thus find, from the uniform character of rocky mountains in cold latitudes, that the intention of Nature has been to render them reflectors to accelerate the melting of the ice, and make them instrumental in giving heat to valleys. Of this we shall become farther convinced by contrasting them with the parasol mountains of the south, which carry fertility to the top of their elevated ridges, while the others concentrate fer-

tility in the bottom of valleys. One is almost induced to think that the parasol mountains of the south are raised above the circumference of the globe, and that the reflecting valleys of the North are, as well as their mountains, hollowed into that mass of granite which appears to form the inward substance of the earth, and becomes visible in various directions as we approach the polar region. A farther proof of the reverberating effect of mountains in frozen countries will be found on comparing them with the hyemal, or snow-covered mountains, which run in long chains throughout the midst of the torrid zone, and afford such a refreshing coolness. The latter bear their glaciers on summits of a great height, cut like artichoke leaves; so that the ice remains there in a great measure all the year through, melting very gradually, and meeting a number of obstacles in running off to the valleys below. The reflecting mountains of the North are, on the contrary, often separated from each other, and arranged in a circular form, with sloping or pointed summits on which the ice and snow cannot long remain. At the same time the valleys which form separations between them are generally of the shape of a scoop; so that when the ground acquires warmth towards the poles from the mixed effect of its subterranean waters

and of the solar rays in spring, these enormous masses of ice, accumulated in the course of a six months' winter, become detached from the soil which melts them at their foundation; and their whole circumference being loosened, fragments fall off and glide away like a vessel launched into the bosom of the deep, the currents of which soon carry them to the southward. It has been truly observed that the chief part of the icy masses of the North roll into the sea, and that when they are melted so far inland as to give rise to streams, the latter are rather temporary torrents than rivers. Such, says Martenz, is the case in general in Spitzbergen. But the ice of the southern mountains is melted gradually, so as to keep up a freshness in the atmosphere, and to feed, with little interruption, the rivers which it is intended to supply. Without these admirable arrangements, ice would be accumulated to no purpose, year after year, on the poles; whereas, by the aid of reflecting mountains and sea-currents, it is now loosened and enabled to seek a milder summer. Nor would it ever have remained on the heights of the torrid zone, had it not been fixed in the frozen part of its atmosphere by mountains so formed as to oppose obstacles to its rapid melting and descent.

The reverberating mountains in the interior of

Finland are much less extensive than those of the islands and coasts of the frozen sea; but the proportions of both are similar. They are in harmony with lakes, or with the Baltic sea, in the same way as the others are with the ocean. I have treated of Finland in the course of my works, and have spoken repeatedly of its hills of solid rock of a single piece, shaped like a stone set in a ring, the waters of which communicate with those of the adjacent valleys, and flow into the lakes. I have likewise made other observations in this country which may be subsequently communicated to the public; but it is proper to mention that my travels took place only in the middle of summer, and that I had too many personal avocations, as well as too little knowledge of the works of Nature, to make such accurate observations as might have been desirable. I considered that country as a place of exile, and being full of solicitude to return home, I travelled hastily through it with the eye of an engineer who looks chiefly to positions of attack and defence. I must add, also, that I was then actuated by the prejudices too natural to us, to treat as a work of disorder whatever is not within our range of comprehension, or in conformity to our favourite system. I shall therefore endeavour to make up for my own deficiencies by the

topographical sketches of others, I mean by the observations of Maupertuis on Lapland, and by those of Martenz on Spitzbergen. These works will enable my readers to form at once an idea of the reflecting mountains of the North, and of the sluices in that part of the world for the supply of the ocean;—they will amuse likewise, by the difference of manner between a plain man, without pretensions to education, and a regularly-bred academician.

Maupertuis, in his observations on the figure of the earth, makes the following remarks.—"Pello is a village inhabited by Finlanders, near which is Kittis, the least elevated of all our mountains; it was there that our signal was placed. In the way up there is a spring of the purest water, flowing from very fine sand, and preserving its liquid state during the most intense cold of winter. When we returned to Pello towards the end of winter, at a time when the sea at the bottom of the gulf and all the rivers were as hard as marble, this water continued to flow as in summer." Maupertuis says nothing of the shape of this mountain, but merely observes it was situated in 66° 48′ of north latitude, and is lower than any of the neighbouring mountains. We are thus justified in considering it as a kind of focus of reverberated heat, and to ascribe the

continued fluidity of its stream to that cause. A similar effect appears to be implied in his description of the neighbouring mountains; particularly in that of Noëmi, situated in the midst of water. "This mountain," he says, "which the surrounding lakes, and the various obstacles in the way to its approach, rendered like an enchanted spot in a fabled region, would have been delightful in any other country than Lapland.—We find on one side a clear wood, the soil of which is as level as the walks of a garden; the trees by no means prevent persons from walking through it, or from contemplating a beautiful lake which bathes the foot of the mountain. On the other side, we find halls and cabinets apparently cut in the rock, and wanting nothing but a roof. These rocks are so perpendicular to the horizon, so elevated and so smooth, as to resemble rather walls begun for a palace than a work of nature."

I cannot say whether Maupertuis, whose mission into Lapland was directed to the measurement of a degree of the meridian, for the purpose of calculating how far the earth was flattened towards its poles, was correct and precise in his scientific observations, but he was by no means so in his reasoning and style. It is not the difficulties attendant on the approach to a mountain,

that give it a resemblance to enchanted spots, which, moreover, occur more frequently in nature than in imaginary pictures. Still less can I see how such a mountain as Noëmi would be delightful in any other situation than in Lapland. The more gloomy its environs, the more must its particular beauty be interesting by the contrast, although we can hardly call it interesting under the pen of so dry a writer. Nor ought he to have applied to rocks the epithet of "so perpendicular," that word implying an immoveable line, and admitting neither of increase nor diminution. After all, how feeble an idea does he give us of the height of these rocks, which seemed, he says, more like to the walls of a palace than a work of nature! This courtly philosopher, by ranking a mountain in a secondary line to a palace, shows clearly that his imagination was more impressed with the power of the kings who had sent him thither, than with the power of Nature. The mountain Noëmi, forsooth, would have appeared to him charming in any other situation than in Lapland, meaning, no doubt, in the park of Versailles or of Potsdam. Does not this justify the suspicion that he would have attached little consequence to scientific inquiries of any kind, had they not been patronized by the great?

We are enabled, however, to form some idea of the nature and colour of these perpendicular rocks, shaped so as to have a reverberating effect, by the observations of Maupertuis on the mountain of Kakama. "The whole summit of Kakama," he says, "is of white stone, foliated and separated by vertical planes which cut the meridian *very* perpendicularly." "That of Horrilaxera," he adds in another place, "is of red stone variegated by a kind of crystals, white, long and *sufficiently* parallel to each other." He experienced on the top of the latter a great degree of heat in the month of July. It is probable that these badly-described rocks consist of granite, and are of the same nature as those which cover Finland. The colour and shape of these mountains conduce, no doubt, to give them a reverberating effect. We shall be farther convinced of this, when we consider that all the mountains of this country, where the astronomers fixed their triangles, had those steep sides which Maupertuis calls halls and cabinets, along with a lake at their base, or in their neighbourhood. Such are Kakama, Niewa, Cuitaperi, Avaraxa, Horrilaxera, Noëmi, Pullingi, Kittis, and many others; for throughout all these northern regions there is hardly a mountain without its lake, nor lake without its mountain. Besides, the valleys of

Lapland, as well as those of Finland, are covered with fragments of rocks which, by reflection, contribute to increase the power of the solar vapours. It seems therefore to admit of no doubt that the mountains of Lapland reverberate, *in connexion with the lakes.*

We shall now proceed to examine other rocks and mountains, fashioned on a much larger scale, and operating, in connexion, not with lakes, but with the icy ocean. Frederic Martenz, a native of Hamburgh, actuated by a desire of making observations on subjects of natural history, embarked, in 1671, in a vessel going to the whale-fishery on the coast of Spitzbergen. His interesting narrative is inserted in the "Collection of the Voyages of the Dutch in the North." I shall confine myself strictly to that which bears relation to my subject. He begins by explaining the name Spitzbergen, derived from *spitz*, a point, and *berg*, a mountain, which was given to this forbidding region, in consequence of the sharp and abrupt appearance of its hills and mountains. Its most southern quarter lies in north latitude 66° 30′. Martenz sailed along the coast so far as 81°, beginning his observations on the 18th of June, and concluded them on the 21st of July of that year. "Spitzbergen," he says, "is surrounded by very lofty mountains,

which seem in a manner to forbid our approach. Their bases appeared on fire; their summits are covered with mists, on which we saw parhelia (mock-suns) from time to time; and the snow, which rose from the bottom of their valleys to the height of mountains, reflected as bright a light as that which is given by the sun in clear weather. Bays are frequently found along the coast; the country is stony throughout its valleys, as well as at the bases of the mountains, which are pointed and of a prodigious height. Most of them consist of a single piece of naked rock, full of cracks and crevices. At their bases and in the valleys we saw mountains of ice, of such a height as even to surpass that of the natural mountains. We observed seven principal mountains all in the same line; they were pyramidical, and were accounted the highest in the country; and well they might, since a part of them rose to the clouds. They appeared of a beautiful blue, and the snow that covered their summits was more luminous than the sun itself. The ice under these clouds looked very dark, and was full of clefts and hollows made by melted snow and rain. However, this darkness and the blue clefts of the ice produced a diversity highly agreeable to the spectator, the effect of which was rendered

still more picturesque by the fiery appearance of the bottom of the rocky mountains."

These rocky mountains send forth a very pleasant smell, similar to that of our meadows, after rain, in spring. Their lower parts are covered with heaps of rocks of a grey colour with black veins, which shine like silver ore. All kinds of grass grow upon these broken rocks, particularly on the spots protected from the north and east winds. A stone thrown down these mountains resounds in the valleys like the noise of thunder. At the harbour or road-stead, called the Magdalene, these rocks are disposed in a circle or semicircle; and on each side there are two lofty mountains, hollowed within as if stones had been extracted from them. In their hollows were other mountains of snow, which rose to the summit of the neighbouring rocks, like trees with their branches. Martenz experienced at sea, at the distance of several miles from these reverberating coasts so strong a degree of heat as to melt the pitch on board his ship. He perceived no channel for a river in the bays through which he passed. In a spot frequented by the crews of vessels engaged in the fishery, and called the "kitchen of Haarlem," he found four houses, an anvil, a pair of pincers, and several other utensils

which adhered strongly to the soil in consequence of the ice. There was here, likewise, a tomb with a cross over it, along with a corpse, which, agreeably to the inscription on the cross, had been buried there during ten years. The body was lying in its clothes without having undergone any change, although the snow was at that time melted in the small valleys between the rocks.

The empire of Flora was found to extend even unto these desolate spots. Martenz gathered there a kind of aloes, (the *limonium maritimum*) with flesh-coloured flowers, a little species of houseleek, four species of ranunculus, cochlearia so useful to scorbutic patients, red sorrel *(rumex sanguineus)*, several plants which resembled misletoe, pilosella, periwinkles, strawberries, and several species of moss, along with white poppies in flower, which he and his companions stuck into their hats. The seas of Spitzbergen contain fuci and algæ of a great length, along with a quantity of the largest fishes, particularly whales. There are found also on its coasts a surprising number of sea-birds of different kinds, of sea-horses and calves, and of white bears extremely fierce. All these animals are amphibious, and make the neighbouring rocks re-echo with their cries.—There are here, likewise, troops of rein-deer, which withstand all the severity of winter, and are

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fond of frequenting one of the bays of Spitzbergen, which has consequently been called after them. The rein-deer was evidently created for these rugged and icy regions. Its broad and forked foot enables it to traverse snows and rocks; its thick and shaggy skin protects it from cold; its fleetness and palmated horns, from wild beasts. The four teats which it carries like the cow, although it rears only one of its young at a time, appear reserved for the use of man, whose empire is extended by Nature throughout every climate.

Let us now bestow attention on the leading circumstances in the description of Spitzbergen; on its large reverberating rocks, the sides of which are perpendicular, and sometimes concave; on the heat which they exhale; on the lofty mountains of ice, the summits of which ought to be nearly on a level, and which have a pyramidical shape in consequence only of the operation of their collateral rocks. In the place of these large rocks arranged in a circular form, put plains, or mere hills, as in our climates; snow, accumulated to the height of many hundred feet by a nine months' winter, is not likely to be melted so as to uncover the soil. There could be neither plants, birds, quadrupeds, nor men, in such a spot. Ice would go on increasing from age to age; clouds wafted from the sea would cause an

endless addition to the deposit near the poles; and the globe having lost its moveable counterpoise, would present little else to the sun than its parched torrid zone. On the other hand, suppose in the icy zone reverberating mountains, along with other agents of heat employed by nature; the summer rays will be reflected in rosy tints throughout their vast extent of snow, as soon as the sun appears on the horizon; the icy mountains, heated by the rocks, send forth smoke in every direction; they begin to melt, taking a pyramidical shape at their summit, and becoming loosened at their foundation; they glide down in their sloping funnels, and are precipitated with prodigious noise into the bosom of the ocean, where, surrounded by fogs, parhelia, and rainbows, they are carried to the southward amidst azure waves, like those nebulous comets which are seen to traverse the heavens in the midst of a serene night.

The intrepid navigators of these northern seas might perhaps succeed in finding a temperate asylum during winter in the sheltered part of the mountains near the sea-side. It is remarkable that the Dutch seamen, who, along with Barents, a pilot, spent a winter at Nova Zembla, about the seventy-first degree of north latitude, were almost killed with cold, and that the cavity which

they constructed was not free from ice in the month of June, while, at the same date, the ice had in a great measure gone away in Spitzbergen at the bottom of the bay called the kitchen of Haarlem, situated in north latitude 77° 30′, the spot already mentioned as the site of four houses. It is, no doubt, in situations such as this that the Laplanders and Finlanders place their villages, as we have just seen in the account of Pello, which is situated in 67° north latitude, and owes to the temperature of its situation the advantage of an overflowing rivulet. Finally, it is possible that Nature has scattered reverberating mountains across the frigid zones, all the way to the pole, in the same way as she projected hyemal mountains across the torrid zones till under the equator. These two kinds of mountains, different as they are in the main, possess some qualities in common. Both serve to temper the sun's heat in the southern countries; the former by their floating glaciers; the latter by their permanent glaciers.

I give the name of hyemal mountains to those which are covered with ice all the year through, and have consequently a perpetual winter on their summits. Their construction is entirely different from that of the reverberating mountains of the north; the latter have their ice at the bottom of their sloping valleys, surrounded by perpendicular

or projecting rocks; while the former have their ice on very elevated summits, the beds of which are disposed around a peak like the leaves of an artichoke, so as to prevent the ice from rolling off. The former appear cut into that granite which is accounted the kernel of the earth; the latter are salient, and raised above its circumference. It is, however, remarkable that reverberating mountains are filled with highly reflecting substances, and that it is in them we find the species of talc so common in the north, and known by the name of Muscovy glass. Moreover, these mountains are disposed in round clusters, while the hyemal mountains extend in long and continuous chains. The radical difference in their shape, and in the nature of their glaciers, may be seen at a glance in the engravings for the voyage of Martenz, and in those of the various journeys to the Alps; but above all in the intelligent and picturesque remarks, with which Ramond has ornamented and improved the work of the Reverend Mr. Coxe.

Hyemal mountains possess several of the characteristics of other mountains, as will be found on examining the Cordilleras. These stupendous masses are sometimes volcanic, notwithstanding the ice which generally covers them. Some of them are Eolian and Anti-eolian; for regular winds come forth from their sides, while they serve, on

the other hand, as a rampart against the prevailing winds of the torrid zone. They come likewise under the description of aquatic, for they attract strongly the vapours of the atmosphere, and fix them in ice on their summits; on this account they are to be considered in harmony with the sea, whose emanations they receive in such large quantities. Thus the chain of the Cordilleras, which extends from north to south, is in harmony with the Atlantic Ocean, while the chains of Atlas and Taurus, extending obliquely from west to east, are in harmony with the Indian seas. They throw out extensive lateral ranges, which are correspondent with large gulfs and mediterranean waters. It may be farther remarked that they attract daily as much water as is necessary for the support of the rivers which flow from them, while they have an immense reserve in ice and snow on their tops; for we find that, when a part only of this icy covering is melted by the sun's heat, the rivers descending from these mountains overflow in all directions, and spread inundations around. This takes place with the rivers Amazons and Oroonoko in America; with the Nile in Africa; and with several of the great rivers in Asia. The probability then is that, were the icy covering of all the hyemal mountains to be suddenly melted, the rivers

flowing from them would receive such an increase as to overflow almost entirely the countries watered by them, with the exception of the mountains. From this I draw the important conclusion that each hemisphere being in a manner one great hyemal mountain, its pole, which is its glacier, attracts daily from the atmosphere as much water as is necessary for the daily circulation of the ocean, by which I mean for the support of its tides. I imagine farther that, when the melting of the polar glacier increases with the heat of the sun, and even of the moon, the ocean overflows to a certain degree, in as much as we perceive a sensible increase in its tides; and if this increase is not in proportion to the increase of a great river, it is owing to the effect of the opposite pole, which, being then in its winter, absorbs in return the waters of the ocean, and places them again in a state of congelation. It seems, however, that, if the glaciers of both poles were to be melted at the same time, the consequence would be a general deluge.

Mountains may likewise be said to belong to the other powers of Nature in consequence of the variety of products they contain. This is particularly the case in the torrid zone, where a lofty mountain comprises almost as many climates as are to be found between the line and the poles,

Hence a succession of different minerals, vegetables, animals, and even men, all varying according to the degree of elevation. Every addition of thirty toises, in these equatorial mountains, is accounted equivalent to a degree of latitude; so that the line of permanent ice begins here at the elevation of a league, exactly as on the globe it begins at 80° north latitude, and 75° south latitude. Such mountains as these are of all situations the most favourable for prosecuting the study of Nature. All the fossils of the earth, as well as all its plants, are to be found here at no great distance; nor is it necessary to dig deep wells in such a spot for the sake of finding mineral specimens. The foundation of all these mountains is, in my opinion, in the lowest part of the globe, and the poles are in the highest. They may be called hemispheres on a small scale, having summer at their base, autumn and spring on their sides, and winter on their summits. It is on account of these general characteristics that I class them in the number of the solar mountains, as they are, like the globe, in positive and negative harmony with the orb of day.

Yet, notwithstanding the vast assemblage of the products of the other parts of the world on these hyemal mountains, they will be found to have some that are peculiar to themselves: dis-

monds and rubies are of this description, for they are not to be found elsewhere than in the torrid zone. It is likewise around the summits of these stupendous masses that the condor flies, the largest of birds. But, without leaving our own climates, we shall find in the Alps a variety of plants peculiar to that situation, and known, in consequence, by the name of Alpine. Although these glaciers, furrowed by the rage of tempests, appear uninhabitable, the cedar shades their snows with its dark verdure, the wild goat skips over their precipices, while the eagle soars in silence round their immoveable seas, re-echoing with the noise of thunder. Thus does Nature, after placing in these elevated dungeons of the earth a focus of its elementary harmonies, conduct thither symbols of its power in organized beings, in the tree which is the king of forests, and the bird of Jove, the sovereign of the skies. It is likewise in the neighbourhood of these spots that man, when in a state of freedom, seeks an asylum; the prudent Swiss at the top of the Alps; the unconquered savage of Chili on that of the Cordilleras; and the innocent Samoiede in the countries adjacent to the pole. It is there that man has not only burst the shackles of political control, but those of superstition, avarice, and all the passions that embitter life. It is there

that the sun, freed from the vapours of the earth, appears in all his splendour; and the soul, shaking off its chains, seems to regain its primitive liberty.

If the hyemal or frozen mountains are relative more particularly to the negative harmonies of the sun, volcanic or fiery mountains bear similar relations to his positive harmony, because all fire proceeds originally from him. Yet both are in relation with water, the former by attracting it to their summits, the latter by purifying it in their craters. We thus find every power in the domain of Nature operating as a wheel within a wheel; and all the parts of her mechanism in correspondence with each other.

Volcanic mountains, as we have already remarked in the Studies of Nature, are destined to the consumption of the sulphur and bitumen generated from animals and vegetables which swim in the sea, and which the rivers bring thither incessantly from the interior of the land. Inexhaustible masses of sea-pitch are formed at the mouth of the Oroonoko on the coast of the Island of Trinidad, agreeably to the testimony of Joseph de Gumilla. There are likewise similar deposits in different parts of the coast of the South Sea, of which seamen make use to careen their vessels. Springs of pitch are found at Sol-

fatara near Naples. I am disposed to think that this pitch flows in with sea-water, even through the layers of sand, along the shore to a certain distance into the interior; and that when it becomes inflamed by the fermentation of the ferruginous particles deposited there, as well as by the fermentation of oily and sulphureous substances; by the rain falling on the strand after a dry season; or, finally, by other means, it becomes the chief cause of earthquakes. These, like volcanoes, are found to take place only in the neighbourhood of the sea or of great lakes.

Volcanic mountains are all of a conical or sugar-loaf shape. Their summit is abruptly cut off, and contains a large cavity of a parabolical figure, known by the name of crater. It is from the bottom of this crater, formed by their explosions, that their fiery contents chiefly proceed; although their lava, or liquified stones, are frequently sent forth from their sides, and directed thence towards the sea. All their craters are at a considerable degree of elevation in the atmosphere. Were volcanoes to burn on a level with the earth, the smoke would be carried by the wind along a great extent of country, so as to render it barren; while at present, the plains adjoining such mountains, in particular those of Naples, are remarkable for their great fertility.

The sides of their craters contribute likewise to the ascent of their fire and smoke into the atmosphere, by preventing the winds from opposing them on their coming out. It might, perhaps, be practicable to prevent our chimneys from smoking by imitating this plan; and by giving them, at their top, craters, the outside of which might be very prettily variegated. I have seen, in the country, a summer-house produce a very pleasant effect by a decoration of this nature. The top of the chimney surrounding its dome was masked by groups of genii, holding in their hands vases, the covers of which were full of holes. The smoke passing through these holes seemed to come out of a censer, and rose towards an Apollo, who stood at the highest part of the dome. I was told that this summer-house had been erected on a plan given by De Wailly, the architect; and I am surprised that some ingenious artist has not followed his example, and thrown discredit on those projecting gutters, which annoy the passengers so much in the streets of Paris. We might make rain-water play in a variety of elegant ways around the roofs of our dwellings and public buildings; and when the smoke of the chimneys of those buildings happened to rise at the same time towards the sky, the effect would be very pleasant. In

such an arrangement utility and gratification would be found to go hand in hand, as in the works of Nature.

I have never been able to see a volcano, although I have more than once endeavoured to satisfy my curiosity in that respect; but had I been fortunate enough to be a personal spectator of so magnificent a sight, I should have felt myself incapable of giving any description fit to be compared with that which Virgil has given us of Ætna:

> Interea fessos ventus cum sole reliquit;
> Ignarique viæ, Cyclopum allabimur oris.
> Portus ab accessu ventorum immotus, et ingens
> Ipse; sed horrificis juxta tonat Ætna ruinis,
> Interdumque atram prorumpit ad æthera nubem,
> Turbine fumantem piceo, et candente favilla:
> Attollitque globos flammarum, et sidera lambit:
> Interdum scopulos avulsaque viscera montis
> Erigit eructans, liquefactaque saxa sub auras
> Cum gemitu glomerat, fundoque exæstuat imo.
>
> *Æneid, III.* 568—577.

> The flagging winds forsook us, with the sun;
> And, wearied, on Cyclopean shores we run.
> The port, capacious and secure from wind,
> Is to the foot of thund'ring Ætna join'd.
> By turns a pitchy cloud she reels on high;
> By turns hot embers from her entrails fly,
> And flakes of mountain flames, that lick the sky.
> Oft from her bowels massy rocks are thrown,
> And, shiver'd by the force, come piece-meal down.

In treating of the aquatic harmonies of the earth we observed that volcanoes had the effect of purifying water, and that they were situated, not only in the neighbourhood of seas and large lakes, but at the extremity of their currents and in the vicinity of their eddies. Thus, Ætna is at the mouth of the ancient straits of Charybdis and Scylla, and Vesuvius at the bottom of the bay of Naples; that is, in a place favourable, like most bays, to alluvial deposits. Mount Hecla, in Iceland, is in a quarter where the general current of the Atlantic proceeds southward in summer and northward in winter; a quarter where tides or counter-currents deposit their bituminous and oily substances, received into the sea from the rivers of the north of Europe and from America. Every year, it is said, a considerable quantity of wood is found there, which is used for fuel by the inhabitants of that island, bared, as it is, of its ancient forests. There is found likewise on the seashore a quantity of turf-land, which is formed, as is well known, of the wrecks of plants deposited by water. The eighteen volcanoes which succeed each other on the western shores of South America are, in like manner, within the range of the eddies of the Pacific Ocean. The counter-currents of the poles, which may be said to bathe the bottom of these mountains, and the

south-wind, which blows there throughout the year, bring to this central spot most of the substances which float in a dissolved state throughout that vast expanse. The consequence is, that its coasts can be approached only at the back of islands, and that they are subject to frequent earthquakes. The volcanoes of other parts of the world are found in similar positions; such are those of the islands of Sumatra, the Philippines, and New Guinea. Most of them are situated in the torrid zone, and particularly in the central part of that zone: not on account of the imagined protuberance of the earth under the equinoctial line, but rather from a contrary cause; for the ocean seems to me to extend to a greater width in that zone than elsewhere, from the earth's surface being lower there than in other parts. Moreover, the grand currents from the pole make there most of their alluvial deposits, as may be seen in examining the sands and shoals which surround New Holland at a distance, and make its shore inaccessible to large vessels. It is in this zone, likewise, that the South Sea abounds with rising islands, founded, not on sand, but on cones of immeasurable depth, raised by invisible insects, which construct ponderous rocks of madrepores with the mineral contents of the waters. Finally, the number of

volcanoes, situated near various parts of the seas of the torrid zone, seem to prove that Nature has multiplied them in that quarter for the purpose of purifying adjacent waters.

It is very remarkable that in former ages there were more volcanoes in activity than at present. Several are found in an extinguished state in the islands of the South Sea, and on the coast of Peru. Neither the Peak of Teneriffe, nor that of Ætna which appears so formidable in the descriptions of Pliny and Virgil, is often in the present day in a state of inflammation. This diminution of volcanic fire may be supposed to arise from the reduction of the quantity of trees, with which the uninhabited part of Europe was formerly covered, and perhaps from a partial reduction in the depth of the waters of the ocean. In regard to volcanoes in the heart of continents, like those of the Vivarais, of Lower Languedoc, and of Auvergne, I cannot help thinking that they were formerly in a very different position; I mean that they were surrounded by water in an age when the situation of our poles was not the same as at present. The formidable fragments of their lofty mountains, and of the steep islands placed at the extremities of the same diameter, look like the ancient axis of the globe, burst by ice and by winter torrents. Again, if you draw

between the supposed situations of the ancient poles a zone equi-distant from both, you will carry it through the present poles, and find it crowded with monuments of the torrid zone. Siberia will show you mines of gold and skeletons of elephants buried on the banks of the Irtis; Holland, remnants of palm-trees near Amsterdam, and the great bones of crocodiles in the quarries of Maestricht. England will produce for your inspection relics of the rhinoceros; Normandy, the *tridacna gigas*, that great shell-fish of the Moluccas; the hills of Montmartre, skeletons without number of an animal of the tapir kind, but with a three-forked foot; while Burgundy produces elephant bones at the highest point of the canal lately constructed by Gauthey the engineer. The provinces just mentioned, I mean Auvergne, Vivarais, and Lower Languedoc, raise aloft their volcanized summits, which all analogy leads us to suppose to have been formerly adjacent to the sea-shore. This, however, is but a small portion of what I suppose to have formerly been exposed to the solar rays in the range from north to south. Future investigations may perhaps discover, near the straits of Java and the isthmus of Suez, monuments of vegetables and animals of the ancient frozen zones; remnants of firs and bones of white bears under the roots of

cloves; as well as moss and rein-deer-skeletons on the sides of mountains crowned with the cocoa-tree. The fragments of rocks spread over all these lands seem to indicate the prolonged operation of the rudest winters.

If the sudden introduction of fire into a solid body is sufficient to fracture it, as we know by experience, the same cause may produce a union of fluid bodies, as we see in the case of congelation and crystallization, both of which assume regular shapes converging to the same centre. If a drop of evaporated water be struck with cold, it is changed into a snowy star with six radii in winter, and into a polyhedron of hail with six sides in summer. A drop of glass, liquefied by fire and struck by water, produces a still more surprising phænomenon; I mean that of the Dutch tears (or Prince Rupert's drops), the thickness of which is such as to resist the stroke of a hammer, and to admit of being filed without falling to pieces. It becomes immediately reduced to powder on breaking its smaller end. It seems a crystallization, the focus of which is not in the centre, but in the tail, which is decidedly stiffer than a wire of glass of the same diameter. This phænomenon, however common, has always appeared to me difficult of solution, notwithstanding the explanation of naturalists. All that I am

disposed to conclude from it is that the basalt columns with five, six, or seven sides, found so frequently in Auvergne, in the island of Staffa, and at the Giant's Causeway in Ireland, are perhaps nothing else than masses of earthy matter vitrified by volcanoes suddenly cooled, and crystallized by the water of the sea into which they have run. It is probable that similar masses, liquefied by fire, may have become crystallized in the way of Prince Rupert's drops, on being plunged into water; and may, in bursting, produce, in the heart of the earth, those frightful earthquakes and sudden explosions, the effect of which is felt at the distance of so many miles.

I am conscious that these explanations will be found to differ from those that I have formerly given of the same phænomena; but I see no harm in the discrepancy. We must consider ourselves short-sighted mortals, aiming at a mark beyond the range of our eye; the more numerous the darts we throw, the greater is our chance of hitting our object. Moreover, all that our progress in art enables us to perform on a small scale will be found equally to exist on a large one. Volcanic mountains have, like other mountains, minerals peculiar to them, and which are as characteristic as their shapes. Although their fires and burning ashes create barrenness around them,

their base and a part of their sides are covered, soon after an explosion, with a fertile mould. By purifying the surrounding waters they volatilize, in the air, salt, oils, spirits, and all the elements of the vegetable system, of which they are both the grave on the sea-side, and the cradle in the atmosphere. Who has not heard of the fertility and happy temperature of the valleys of Peru, surrounded at once with icy and fiery mountains? It is on the sides of Vesuvius that the delicious grape, called lachryma Christi, is gathered; it is on the borders of its gulf that the most voluptuous inhabitants of Rome were in the habit of planting their gardens. It was likewise in the plains of Sicily, at the foot of the sides of Ætna covered with vines, olives, and stately chesnuts, that Europe raised, in the midst of corn-fields, the first altars to Ceres: I say Europe; for, according to Plutarch, offerings were sent thither from the remote countries in the north, known by the name of hyperborean.

Whether these volcanic mountains have vegetable products of a peculiar kind, I am not apprized; but they have animals which are not found in other situations. Father Dutertre, in his description of Guadaloupe, the best and most beautiful, in his opinion, of all the Leeward Islands, speaks of an extraordinary bird which

inhabits its volcanic mountain, called la Souffriere. This creature, called the devil by the inhabitants on account of its deformity, is both a night and sea bird. During the day its vision appears to be indistinct, and it takes refuge near the top of the mountain, where it has its nest in the ground, and where it hatches its eggs. During the night it flies about and goes to prey on fish. Its flesh is so delicate, adds Father Dutertre, that no huntsman returns from the Souffriere without ardently desiring to have a dozen of those birds suspended at his neck. Labat, the colleague of Dutertre, confirms and adds to the account of the latter. "The bird, called the devil of la Souffriere, has," he says, "membranes at its feet like a duck, and claws like a bird of prey, a sharp and curved beak, large eyes which cannot bear the light of day or discern almost any object, so that when surprised in the day-time, at a distance from his nest, he runs against every thing in his way, and falls to the ground; but during the night he is active in extracting his prey from the sea." Labat adds that he is a bird of passage, and is considered a kind of petrel. I have taken pleasure occasionally in observing fishermen catch fish during the night by the light of a straw-torch; but here we have a sea-bird of much greater ingenuity, which

fishes by the light of a volcano, and hatches his eggs by the warmth of its sulphureous discharge. Thus has Nature provided inhabitants for the most terrific situations. She has drawn from the bosom of the waters a bird to place it in the midst of fire, and if the ordinary petrel deserve, on account of his boldness, the name of the bird of the tempest, the inhabitant of la Souffriere has a title to be called the petrel of volcanoes.

Different situations have different species of animals, but man alone extends his empire over all. The Laplander, like the rein-deer, inhabits the reverberating mountains of the North; the Abyssinian, like the ape, the parasol mountains of Ethiopia; the Chilian, like the lama, the glaciers of the Cordilleras; and the Sicilians saw the philosopher Empedocles fix his abode on the summit of Ætna, where they still go to visit his little tower.

The earth has doubtless other harmonies with the sun, most of which are unknown to us. We shall terminate the present section by taking a view of its harmonies with the moon. There is no doubt of our sending back to that planet a portion of the solar light, but in less clear or lively rays than that which we receive from her, although our globe is considerably the larger of the two. The light given by satellites is, as I

have already remarked, stronger than that which they receive from their planet, because they are disposed like reverberating lamps, and always present the same side to the light; on the other hand, a planet being larger, and turning round on itself, returns them a more extensive though less concentrated light.

I am inclined to think that the effect of lunar rays on the earth is, in point of strength, about a twelfth of the solar rays under the equator, and about a sixteenth under the polar circles. It is singular that gold and silver, the two metals referred, in common acceptation, to those two orbs, should have a relative value of nearly a similar proportion in those different climates. In speaking of the lunar harmonies of the earth, I questioned the accuracy of Bouguer's extraordinary assertion that the light of the moon is three hundred thousand times less than that of the sun. In fact, that academician has made egregious mistakes in the experiments and calculations on which he founds his conclusions. If, instead of glasses placed above each other to reduce the sun's light to a par with that of the moon, he had merely had recourse to the divisions of the atmosphere, he would soon have become aware of the magnitude of his error. According to him, a cherry, visible by moon-light at the distance

of two yards, ought to be visible in the day-time at a distance of 600,000 yards. So far from there being any foundation for so absurd a conclusion, I have observed that an object, seen at the horizon in the day-time, might be perceived just as distinctly during a full moon, provided we placed it in summer within twelve times, and in winter within sixteen times, the distance at which it was visible during the day. These distances vary then in the same proportion as objects placed under the line, and under the polar circles. We see by the light of the full moon a mountain as clearly at the distance of a mile, as at the distance of twelve or fifteen miles in the day-time.

I am not apprized whether the heat of the moon be in the same proportion; but it certainly exercises an influence on all the kingdoms of Nature. An English shipmaster, whose account is printed in the "General History of Voyages," affirms, in the most positive manner, that the heat of the moon is much felt in Guinea. Pliny assures us that it has been known to melt snow and ice. It is no doubt to the heat of the solar rays, reflected by the moon on the ice of the poles, particularly when she is new and full, that we are to attribute the rise of tides at these times. Finally, all our agriculturists are aware how

materially these phases promote the growth of plants.

Mountains, whether of the reverberating or parasol form, whether covered with ice or stored with fire, all give indications of the influence of the moon. They assume magic tints and forms under the influence of her rays: while the sun paints their landscapes with colours, the moon marks them with black and white: the first may be said to make paintings, the latter engravings. Each species of mountain receives some new harmony from the moon. Those of the reverberating kind throw on the rocks and neighbouring trees, situated between them and the lunar rays, tinges of light which disperse their shades, and render them luminous throughout their circumference. Parasol mountains, on the other hand, receiving light only on their elevated levels, cast on their sides and bases a dark shade, which, forming a stronger contrast with their light, makes them look nearer by night than by day. This effect is very well known to seafaring people, and was experienced by us when approaching, during night, the mountains of Corsica. In the dark we thought ourselves so near them as to lose no time in tacking; but an hour after, at dawn, we saw that they were at a considerable distance, and the more the day broke, the farther

off they appeared. Icy mountains appear of a rose-colour at sun-set, and of a silver-colour on the rising of the moon.

Volcanic mountains discover, during the day-time, nothing but a thick smoke; but by moon-light their fires are seen to blaze, and to redden the horizon to a vast extent. Nature seems to have placed them on the sea-shore to give on land that light to navigators which the moon sends down from the vault of heaven.

Terrestrial Harmonies of the Air.

In treating of the terrestrial harmonies of the earth, we explained the manner in which mountains receive, through the medium of winds, a deposit of earth on their summits calculated to counteract what is carried off by water. We are now to explain the manner in which air becomes renewed by means of mountains. Until the present stage of our disquisition, the earth has presented us only with a variety of colours and shapes, or with awful sights, such as volcanoes; she is now about to address our hearing faculty by delightful sounds, by soft murmurs, and by echoes produced by the rocks and winds.

In treating of the harmonies between mountains and air, I reckon two kinds of mountains, the one having harmonies of a negative, the other of a positive kind. To the former I give the name of Anti-eolian, because they shelter vegetable products and animals from the rage of winds. In countries where the same wind blows during nearly the whole year, we are naturally led to conclude that mountains are frequent, as every elevation which is not in the direction of those winds must have one side exposed to them, and another sheltered from them. It is from this

constancy of the wind that we have in the West Indies the distinction of islands into windward and leeward. The windward side of the hill generally rises by a gradual ascent from the sea-side to the tops of the mountains, and these tops are almost always situated towards the lee-side. Streams and rivers descend generally along the windward side, because it is to that side that the winds bring clouds and vapours from the sea. The lee-side is not only steep, but frequently deficient in water; its chief advantage is in possessing roadsteads, and sometimes even harbours, formed by Nature. A correct map of South America would give a very clear representation of these topographical arrangements; it would exhibit, on the side where the east wind blows regularly, a gradual rise throughout a great part of the Continent from the borders of the Atlantic Ocean to the summit of the Cordilleras, which approach, as is well-known, the shores of the great South Sea. This vast amphitheatre is watered by a multitude of rivers, of which the Amazons is the largest; while, on the opposite side, there descend from the Cordilleras into the South Sea only a few streams, which, after refreshing the narrow valleys of Peru, are generally lost in the sands.

There are some Anti-eolian mountains of a

character still more determinate. They may, without impropriety, be called undulating hills, on account of the regularity of their shape, and their small degree of elevation. They have no salient and re-entering angles, like those which, in other situations, serve as a kind of natural dike to rivers; but they are parallel to each other. Such are those which run along the plain of Thibet, and which, in that part of the earth, one of the loftiest regions of Asia, presents an appearance like the waves of the sea in a state of agitation. Mountains of a similar character are found in different parts of Tartary, and seem destined to shelter, in their small and numerous valleys, vegetable products from the blasts which are so violent in those elevated regions. It is in the backs of these mountains, and at the bottom of the adjacent valleys, that we find growing the broad-leaved rhubarb, and the ginseng, so much boasted of by the Chinese as a restorative of exhausted strength. They often supply food to flocks of wild sheep, which are perhaps more beautiful and more vigorous in this quarter than any other species of that animal in the world. In rapidity in running they are said to approach to dogs and horses, and some naturalists even consider the sheep a native of these countries, as the camel is of Arabia, and the camelopard of

the south of Africa. The sheep, we know, prefers our airy hills to our plains, and possesses, in its curled fleece, a still greater protection from the wind than from the cold. Animals inhabiting cold countries, such as wolves, martins, and foxes, have long, tufty, and silky furs; but the latter are not like the hair of wool, which, by becoming interwoven, forms a fleece, in a manner, of a single piece, impenetrable to the wind. A sheep is not a northern animal, for it degenerates in such a latitude; and it is of importance likewise to remark that the wind blows with greater violence in southern, and in temperate countries, than in cold regions, as we shall see in our future investigations.

There are some mountains which, so far from affording a shelter to the land against the wind, have the singular effect of raising winds in very calm weather; such are the mountains in Italy, known by the name of Eolian, and situated near the town of Cœsium. These mountains, as we have already observed, are full of caverns, and when the sun warms and rarefies the neighbouring atmosphere, the air contained within the caverns becomes dilated and bursts violently out in blasts, particularly through a gate made in the mountain by the inhabitants of Cœsium.

In the West India islands, mountains produce

effects of the same nature in a still greater degree, and in a much more regular manner, since they send forth every night winds known by the name of land-breezes, which blow in a diverging direction from the centre of each island to a distance of several leagues at sea. On the other hand, the sea-breeze blows there all day long. Dampier, the navigator, mentions, in his "Treatise on Winds," a number of places situated likewise in the torrid zone, where land and sea breezes prevail alternately by night and day;—of this description are, in America, the isthmus of Darien, where, during night, the land-breeze proceeds even from the interior of the continent; the bay of Panama, Guayaquil, Païta, the bay of Campeachy, and two small archipelagoes of islands in the south of Cuba, Jamaica. In Asia, he mentions Bantam in the island of Java; Achen in Sumatra; the coast of Coromandel on the Indian continent, &c. To this ought to be added the coast of Africa throughout the torrid zone, and particularly the coast of Guinea, which is refreshed by a sea-breeze every day from eight o'clock in the morning till sun-set, after which a calm takes place for some time; but a land-wind rising blows during the whole night, and ceases at day-break.

Some celebrated naturalists have accounted for

this succession of land and sea breezes by supposing the mountains from which they proceed to be hollow, like the Eolian mountains of Cœsium. They imagine that during the day they are filled with the sea wind, and that they subsequently send it forth during the night. To this opinion I can by no means accede; for it supposes the existence of two causes, one of which is of very rare occurrence, while the other is in a manner beyond our comprehension. The first is the supposition of these mountains being hollow, a circumstance that very seldom happens in any country, whatever may have been sung by poets or taught by ancient philosophers, who are in the habit of considering caverns as the first abode of man in every latitude, and of explaining a number of physical effects by this convenient assumption. I have travelled to some extent, and I never saw but one natural cavern, if indeed that name can be given to a subterranean channel filled with water in the rainy season. This was in the Isle of France; the channel came from the interior of the island, and fell into the sea at a part of the coast called Pointe des Caves. I went down into it at the distance of nearly a league from its mouth, by means of a hole formed in its vaulted covering; and I walked along it for a length of nearly a

thousand feet, by torch light, for day-light enters it only in spots where the roof has fallen in. Such a recess is wholly unfit for the habitation of men or quadrupeds, being full of water in the rainy season, the time at which shelter is most wanted. The second and still more contradictory supposition implied in the theory of the Eolian mountains in the torrid zone having internal hollows, is that these hollows must be of prodigious extent in order to contain the quantity of wind blowing in all day long, and blowing out all night to a distance of several leagues at sea, with a violence which is often such as to dismast ships. Were not these winds occasionally formidable, they would not have received from our seamen the name of *brises* (breezes), and still less of *brises carabinées* (gales). It would farther, according to this fanciful theory, be necessary to suppose that there are, in the sides of these hollow mountains, a number of vent-holes, that the winds may make their way along the whole extent of the mountain's side, and, moreover, that there should be, in these hot climates, a quantity of glaciers to refresh those nocturnal winds; for they are so cold that persons venturing to sleep in the open air, without throwing a covering over their breast at least, are apt to lose the use of their limbs.

Now it is very well known that the mountains of Italy, called Eolian, have none of those mechanical accommodations.

Natural philosophers are in the habit of accounting for the properties of their machines by the laws of nature, and no doubt with justice; but they are apt likewise to attempt to solve natural phænomena by the rules of their machinery, and here they are liable to great mistakes. Although it does not enter into my plan to enumerate the causes of all phænomena, I cannot help, when combating the suggestions of others, attempting to substitute for them a solution derived from the actual observation of Nature, and capable of being put to the test of experience. I shall venture accordingly a short explanation of the cause of the daily sea-breeze, and the nightly land-breeze, of islands in hot countries. Such an explanation will tend to convince us more and more of the harmonies prevailing between all parts of the globe, and of the necessity of studying geography as a science founded on principles of certainty.

We may begin by laying it down as an undoubted truth that, whenever air is dilated, the surrounding air will rush thither and produce that current which we call wind. If we suppose the sun at the horizon, and warming that part of

the continent of America which is comprised within the torrid zone, the atmosphere naturally becomes dilated, which is a sufficient reason for making the adjacent atmosphere of the Atlantic Ocean rush thither from the eastward. Now the wind comes from the eastward, or from the Atlantic Sea, rather than from the westward, or great South Sea, for two reasons: first, on account of the great height of the Cordilleras, which are at the western extremity of America, and serve in some degree as barriers to the atmosphere; but the second and principal reason is the rotatory motion of the earth, which carries America towards the sun, and presents to him first its east and by degrees its west side, dilating the air of the latter so as to oblige the atmosphere to rush thither from the eastern hemisphere. Again, when the rotatory motion of the earth withdraws in like manner the eastern hemisphere from the heat of the sun, the parts of the atmosphere which possess most density, weight, and spring, naturally rush thither with the greatest degree of violence. On that account the cold and condensed air of the poles becomes joined to the east wind on both sides of the equator, so as to produce, in the torrid zone, the fresh and regular winds of north-east and south-east. Were the earth immoveable, the probability would be that

the winds of the torrid zone would be always in the direction of the poles, north and south. Thus the regular, or trade winds, which prevail on both sides of the equator, are not produced by the centrifugal force of the earth in its rotatory motion, as has been said by celebrated astronomers, among others by Dr. Halley. These gentlemen compare the atmosphere around the equator to the hair of Atalanta when running a race. To give an air of probability to their hypothesis, we must suppose air to meet with resistance; for the centrifugal force of the earth, combined with its rotatory movement, would not have the effect of driving it back. It would turn round along with the earth, and with the same degree of quickness, as would be the case in the down of the cod of a silk-worm, if it were put in motion in a vacuum, and even with the hair of Atalanta, which would evidently accompany her head were her course through the mere expanse of light. Finally, if this pretended centrifugal force has a tendency to make the winds under the line blow in a direction from east to west, how does it happen that these winds are in a diagonal direction, namely, north-east and south-east? How should they happen to be variable, particularly in the South Sea? A thousand objections might be started to Halley's system; but

I state only one, namely, that if a centrifugal retrograde force had the effect of making the equatorial winds rush from east to west, it would have a similar effect on the sea. The current of the Indian Ocean would thus run from east to west, and could not possibly retrograde at the September equinox from west to east, so as to run six months in this new direction. Finally, since the globe turns on its poles, the basin of the sea would form nothing else but a circular channel, under the torrid zone, where all centrifugal force is collected.

Astronomers, it must be allowed, are apt sometimes to reason very much at their ease. On one occasion they represent the atmosphere as subjected to the rotatory motion of the earth, and they withdraw the sea from that dominion, as we find in their theories of the winds. On other occasions, they are disposed to account the sea subject to the gravitating power of the moon, and they withdraw the atmosphere from this influence, as is the case in their theory of the tides; they have no dread of being charged with contradiction, but put themselves under the protection of obscure hypotheses and scientific calculation. As for my part, aiming at nothing but the exposition of truth, I must lay my account with a good deal of indifference on the part of

the mass of mankind, who are disposed to admire only what is enveloped in mystery.

It seems to me to admit of no doubt that the dilatation of the air by the warmth of the earth, and the declivity of the ground, are the primary causes of winds, and of the directions in which they blow. These physical and local causes are of so great influence that, in the part of Africa where the trade-winds regularly blow from the east, a breeze sets in from the west every morning towards eight or nine o'clock, at the time when the sun's heat begins to become considerable. The same applies to the breezes which blow all day long on the shores of the continents and of the islands of the torrid zone; but at sunset these sea-breezes begin to fall towards the land, because then the atmosphere of the sea is too much dilated by heat, or rather, because the atmosphere of the land then begins to become cold and condensed. At the time when the two atmospheres are coming into equilibrium, a calm prevails for nearly an hour, attended with a strong degree of heat, which would soon become extremely inconvenient, did not the mountains of the islands dilate the upper air, or attract it downwards, first to their summits, and thence to their sides and foundation. This, in my opinion, is the cause of the duration, the extent, the force,

and the freshness of the land-breezes in the islands of the torrid zone, throughout the night.

It is the dilatation of the atmosphere by the sun that is the cause of all winds, and of their freshness even in cold countries. It is the sun's heat during the day that makes the polar winds blow in harmony with the east wind on the continent of America, in like manner as it is the heat received during the day from the southern islands, that makes their upper atmosphere blow during the night. Thus when we see in our climate the rainy clouds of the west move eastward during several weeks, we may take for granted that the atmosphere is dilated in some quarter of Russia or Tartary. The cause of the wind is not to be sought in the quarters from which they proceed, but in those to which they direct their course.

How difficult then is it for men to find out truth! Often does it lie in situations quite different from our first observations, and we move forward to seek it at a time when it lies behind us. It is a common notion that the winds take the lead in pushing objects forward, while the fact is that they themselves are either pushed or attracted. The sun appears to the common observer to turn round the earth, and yet it is the earth which revolves on its own axis around him. The splen-

dour of day would seem at first best calculated to show us Nature in all her magnificence, yet we find that it is from the darkness of night that we are to expect the grandest display of the heavens. Moral are like physical truths: we seek often in enjoyment that gratification which we experience only in privation; and this fugitive life to which we are so much attached conducts us only to death, while that death, which to us is an object of terror, opens the way to an immortal life.

To return to the alternation of land and sea breezes: the celebrated Dampier, who considers them with the mind of a navigator, makes the following judicious reflection in his Essay on Winds: "It must be confessed that the land and sea breezes are the result of a particular dispensation of Providence in this part of the world, where the prevailing sea-winds reign to such a degree that navigation could not be carried on without the aid of land-breezes; whereas, by means of the latter, one is enabled to proceed two or three hundred leagues in a contrary direction to the prevailing wind." In fact one may proceed a good deal farther; Nature has a thousand means of attaining the same result. To facilitate navigation she distributes winds to certain islands every night, to others every month, to others every

season, as is the case in those that are within the ranges of the Indian monsoons. She has formed in Italy Eolian mountains with caverns; while in the torrid zone she has produced mountains of a different structure, and of much more powerful operation. The latter have in general a peaked top, which has no doubt the power of attracting air, as well as of attracting the clouds which incessantly surround them. I am even inclined to think that volcanic mountains are in part Eolian, in as much as they expand the air by their heat. The south wind, which blows throughout almost the whole year along the coasts of the great South Sea, is perhaps impelled in that direction by the atmospheric dilatation produced by a great number of volcanoes, which succeed each other in a straight line along the mountains of Peru.

It is particularly deserving of remark that the power of land-winds is principally felt on the shores of warm seas. Dampier observes that they are much more violent at the mouths of bays and gulfs, than at the extremities of capes, where indeed they are sometimes not felt at all. He relates that there have been seafaring men so ignorant as to waste ammunition by firing cannon and guns on these capes, in order to kill, as they imagined, the dragon who impeded their navigation. I cannot help thinking that all the spots

in the vicinity of the sea that are noted for gales of wind, have either Eolian mountains, or bays and gulfs which produce them; such are the gulf of Lyons in the Mediterranean, and the island of Tristan d'Acunha, where I have personally experienced violent storms. On the other hand, I imagine that capes are Anti-eolian mountains, on one of the sides of which vessels may always find a shelter from the wind; and if some of them are famous by their hurricanes, such as Cape Finisterre at the extremity of Spain, and the Cape of Good Hope at that of Africa, it is owing to their being at the mouth of a gulf or strait; the former being, in fact, at the place of egress from the Bay of Biscay, and the latter not far from that of the Mozambique Channel. Indeed it is at the mouth of the latter channel, and not in the immediate vicinity of the Cape of Good Hope, that the mariner is assailed by those terrible tempests, which have given that cape the name of tempestuous. In support of these assertions I appeal to the journals of navigators, and to my personal experience.

Moreover, the fresh nightly breezes from the land are felt both in the islands and along the coasts of the torrid zone, particularly at the sea-shore and at the bottom of bays, into which eddies, aided by breezes from the sea, bring all

day long the fragments of a variety of substances. These would accumulate so as to be productive of dangerous effluvia, were they not thrown back into the open sea, during the night, by the land-breezes. The wind, as we have already remarked, blows downward, being always strongest at the tops of mountains and on the borders of waters. La Fontaine was perfectly aware of these circumstances, and expressed them very happily in the fable already quoted of the "Oak and the Reed:"

> Tout vous est aquilon, tout me semble zephir.
> Encore si vous naissez à l'abri du feuillage
> Dont je couvre le voisinage,
> Vous n'auriez pas tant à souffrir;
> Mais vous naissez le plus souvent
> Sur les humides bords des royaumes du vent.

The poet expressed himself like a naturalist, in giving the wind several kingdoms, and in planting his humble reed in a marsh, while he raised the proud oak to a lofty situation. Vegetable products growing on mountains and along the sea-shore have generally thin capillary, sessile, woody leaves, capable of resisting the winds. The leaves of the oak are tough as bark, and are fastened to very hard stalks; their trunk, moreover, is knotty and strong. Some of these old oaks in the mountains exhibit, with their large crooked

branches, the attitude of a combatant striving against the storm. Aquatic vegetables, on the other hand, have pliant stalks and sessile leaves, as we see in osiers, willows, rushes, and reeds; those which, like nymphææ, have a broad foliage, drop it generally into the water, so as to give little hold to the winds. In the Eolian mountains, and on the sea-side in the torrid zone, vegetable products have supple stalks with leaves that are woody, of considerable length and with branches; such in particular are the palmettoes of the mountains. Their stem, which is often a hundred feet in height, carries its palms higher than the surrounding forest; it is so elastic that in a storm it bends like a bow, and its bark is so hard as to repulse the stroke of the hatchet: the inside of its trunk consists, as I have already observed, of a compact body of fibres. It is on heights of the same description that we generally find creepers, which, like cables, fasten around trees, and give them strength to withstand the rage of the hurricane. The bark of these creepers is so strong that straps of it are preferred to the best ropes. The same qualities of pliancy and elasticity are found in the stalks and leaves of the bamboo, the fan-palm, and the cocoa-tree, which grow on the borders of the sea; in general the leaves of palm-trees of all kinds are so woody that the

Indians use them as tablets, on which they write, or rather make figures, with an iron bodkin.

Eolian mountains have not only vegetable products, but animals of a description peculiar to themselves. I shall not here enumerate the different sea and land birds which make their nests on them, and thus bring up their young in the midst of storms. Some of those birds, like the ospray, the coot, and the eagle, being in the habit of struggling against the wind from their infancy, are able to fly in an opposite direction to the most violent tempests. But there are quadrupeds which appear particularly destined for such situations; such, among others, is the lama of Peru, an animal still better suited to the Eolian mountains of the Cordilleras than to their glaciers. His fleece is thick and curled like that of a sheep; his feet are armed with claws with which he rapidly ascends the rocks; his neck is long, his head small, and his nostrils wide, to enable him to breathe with ease. All these characters, common to him with the camel, who is exposed to the sandy tempests of Africa, are perfectly suited to an inhabitant of Eolian mountains. Nature produces in abundance, in the mountains of America, a rush called *ycho,* which is the favourite nourishment of this animal. In these lofty regions the winds rage so violently, that Thomas

Gage, the traveller, relates that he was obliged, by their impetuosity, to stop during two days and a night near the top of a mountain of New Spain, called Maquilapa, or "bald head;" and he would have been dashed into the South Sea, which he saw rolling at the base of the mountain, if he had not at last determined to proceed on all fours like a lama. Nature has put in the Eolian mountains of the West India islands a quadruped totally devoid of hair; I mean the armadillo, which is covered with scales, and rolls on its heels by putting itself in the shape of a ball like a millipede.

Eolian mountains have not only plants and animals, but men likewise fitted to inhabit them, at least in the part from which the wind is chiefly discharged. Of this description are the Tartars and northern Chinese. The countries which they occupy are situated at the foot of vast mountains of this description, thrown in an amphitheatrical form, along the northern part of Asia. Every day, according to Isbrandides and the Jesuit missionaries, there issues from these mountains such a quantity of sand, that the inhabitants of Pekin cannot venture into the streets without wearing a crape on the face. I account for the small eyes which are characteristics of the Tartars and northern Chinese, by these violent

sandy winds, which oblige them perpetually to wink with their eye-lids.

Eolian mountains, however, have harmonies with men, of a less disagreeable kind. They receive, during the day, the winds of the sea in their defiles, and they re-echo the sound of the waves in the midst of forests. On the other hand, they cast out during night the perfumes of vegetable products to a great distance at sea, and it sometimes happens that an island is discerned by the smell before perceiving it by the eye. On drawing near to the Isle of France, I observed our scorbutic invalids become all at once indisposed, without our perceiving any appearance of land; yet I thought it difficult to account for so general and sudden a weakness, without ascribing it to the influence of vegetable products at a distance. I had on board a little dog affected likewise with scurvy, who, on turning his nose to the wind, seemed to inhale with great delight the emanations of the invisible land.

It is clear therefore that Eolian mountains are not the work of chance. Their shape should be studied, were it merely for the purpose of suggesting useful ideas to our architects, in the way of giving, in summer, currents of air to our apartments. An effect of this nature might, I

should imagine, be produced by means of curves, which, in summer, would increase the solar heat at the top of our chimneys. If a fire placed at the bottom of a chimney sends out at the top a blast capable of turning a machine, it seems to me possible, that a similar degree of heat acting on the top of a chimney, would produce a contrary effect below. Something of the kind seems to take place in certain chimneys when the sun warms their tops, and expands the air in them; for the smoke then descends and comes back into the room. The Persians erect in their houses wind chimneys, merely for the purpose of cooling the air; Chardin has given drawings of them, but I cannot speak with confidence of the manner in which they are constructed in the inside.

I cannot too often repeat that architectural students would do well to give attention to the construction of our globe, notwithstanding its apparent irregularity. The science of architecture is already indebted to it for its cement, its mortar, and a variety of other materials. Some philosophers have considered the globe as an organized body, which conceals neither the motion of its organs, nor the course of its fluids, because it bears them on its outside. They imagine it to

have its heat in the sun, its respiration in its atmosphere, its lungs in the Eolian mountains, its voice in its echoes, its veins in its rivers, its organs of secretion in volcanoes, its bones in the rocks and mountains which rise on its surface.

Terrestrial Harmonies of Water.

As in the bodies of animals there are bones of different kinds and dimensions, hard and compact for grinding, porous for smelling, cartilaginous for the voice, and perforated for the passage of the veins, marrow, and sinews; there are, in like manner, in the construction of the globe, rocks of all shapes and qualities. We must by no means conclude that they have been cast about at random, because they are not squared and smoothed with all the regularity of the stones in our public buildings. Volcanoes, torrents, seas, tempests, earthquakes, are the instruments, I may almost say the scissars and mallets, of Nature. It is by dint of the elements that she gives a shape to the globe. The mountains which pour down rivers from the region of clouds, the irregularities of their sides, the abysses of their foundations, the fragments and wrecks of various substances, are all to be considered as materials for workmanship in the hands of Nature. That which to our eye may seem replete with demolition is by her rendered instrumental in maintaining the solidity of her fabrics. There are perhaps more plants and animals called into existence for her sands, her broken rocks, and her

steep mountains, than for her extended plains, and the beautiful curves of her hills. In treating of the terrestrial harmonies of the sun and air, we found that there were four descriptions of solar, and two of aërial mountains. We shall now find that there are two others of a similar character in the terrestrial harmonies of water, I mean hydraulic and littoral mountains; the first attracting the waters, and the others serving as barriers against them.

We might, no doubt, reckon among the hydraulic mountains those which we have called hyemal, as they attract the waters of the atmosphere, and fix them in the shape of ice on their summits. In like manner we might class among littoral mountains those volcanoes which are found on the sea-shores, and whose fires I consider to have the effect of purifying the water. But we have already classed them both among solar mountains, because the former owe their icy covering to the absence of the sun, and the latter their peculiar character to the presence of fire, which proceeds originally from the orb of day. The former belong to the negative, the latter to the positive harmonies of the sun. At the same time, it is fit to add that, by their shape and position, the former come under the class of hydraulic, the latter of littoral mountains. Each

work of Nature serves at once for several purposes. In the immensity of the conceptions of the Creator, every point in the universe is the centre of an unknown sphere, but in the feebleness of our views we catch only a few points of an object.

We shall at present confine our observations to hydraulic and littoral mountains properly so called. The former present to us two kinds, one of a gentle slope; another of an amphitheatrical form. Littoral mountains may, in like manner, be divided into two kinds, the one bordering on the sea, the other on rivers. Each of these species will present us with subdivisions; we shall examine in succession their position and shape, as well as the minerals, the vegetables, and the animals which belong to them.

Hydraulic mountains are those which attract the vapours of the atmosphere by their summits, and pour them in rivers and rivulets along their sides. They are related, in the system of Nature, to seas and lakes; and they embrace inland seas and gulfs by chains and subordinate chains, in order to collect evaporation by means of winds. They are accordingly situated at the extremity of continents and islands, in those positions where the course of the wind is, as in Peru and the West India Islands, regularly the same. But in

situations where the winds blow sometimes on one, sometimes on another side, they are found placed in the interior of continents and the central parts of islands. Such are the ridges of Taurus and Imaüs in Asia, as well as the mountains of the islands and peninsulas situated in the midst of the alternate monsoons of the Indian Ocean. It is easy to trace the chains of those mountains along the map, by following the space of ground lying between the sources of different rivers. This intervening space, which is sometimes left blank by geographers, and sometimes drawn as if full of insulated eminences, will, in general, be found in long ranges parallel to seas which are often at a great distance from them. The rivers flowing down their sides sufficiently show by their magnitude the elevation of their soil; while the angles of the streams falling into them may serve to convey some notion of the rapidity or slowness of those rivers, and consequently to give an idea of the different degrees of height from which they take their source. Thus a spring generally rises from a little eminence; a rivulet from a hill, a river of the second class from a mountain; a first-rate river from a mighty range, like the Rhine from the Alps, or the Amazons from the Cordilleras; and the ocean from the poles.

All these elevations have electric rocks of different shapes which attract vapours and fix them in clouds around them. Some of these rocks are of a straight or inclined pyramidical form; some are like a bee-hive, some tabular, others like the top of a mushroom, as in Finland; and finally others like a breast or pap (in French *mamelle*), surmounted by a peak. This shape of a breast is one of the most frequent, and the name is consequently given in almost every language to the summits of a number of mountains. Popular names will always be found judicious and expressive when they are generally adopted. The name of breast or pap is extremely suitable to these lofty ridges, crowned by a peak, which are the nursing mothers of every country, and the sources of their fertility in consequence of the waters which flow from them. Some of these peaks or pyramidical tops are not conspicuous, but are buried in the sides of the mountain, a position which, however, does not prevent them from exercising their attracting power, as I might show by a variety of examples. The mists which gather on their tops are sufficient to point out their situation on our hills, and if we proceed to turn up the earth, we shall generally find in them some iron-ore and a spring. Mineralogists indeed are in the habit of considering permanent mists

as indicative of metallic treasures. I call these peaks or pyramids hydro-electric, because they attract fire and water at the same time. Wherever I have had an opportunity of seeing them, I have observed that the clouds turned from their direct course, and fell lower down in the atmosphere, where they moved circularly around them. These accumulated clouds then dissolve into rain, and descending along forests which cover the upper part of the mountains, they exhibit the colours of the rainbow in the midst of verdure. Such appearances are of daily occurrence in the Isle of France, on the peaks of the Pouce, of the Peter Booth, of the Three Breasts, as well as on other mountains of that island, where the summits are, however, a good deal below the region of clouds. I have gone up the peak of the Pouce at the bottom of the inclined needle from which it receives its name, and which is not 200 feet in height. This needle, consisting of copper coloured rock, was surrounded by mists which covered it in a great degree, and which, sinking into its moist sides, produced at the base two rivulets, one of which ran on to the harbour, while the other precipitated itself on the steep back of the mountain at a place where miners were then occupied in making a road. The clouds which passed along the neighbouring sky appeared to

me, at this elevation, as high as if I had looked up to them from the bottom of the valley. I have witnessed similar effects at the Cape of Good Hope on the Table Mountain, where clouds are frequently accumulated in such a manner as to make the flat top appear covered with white drapery waving around it. It is on such occasions that the Dutch are in the habit of saying that the table-cloth is laid; a preparation that may well be said to be for the storms, for it is a prelude to violent blasts of wind which very soon scatter the component parts of the table-cloth over the town and road-stead in flakes like those of snow. These flakes do not produce rain, or come in any way in contact with the ground; they are nothing but shreds of thick mist, which remain in a condensed state, although the solar rays pass through, and produce effects well entitled to description at the hands of the painter, and of explanation at those of the naturalist.

The hydro-electric peaks are put together in a variety of ways. Some are insulated, like that of the Peter Booth in the Isle of France, and like Mont-Rouge at Ascension Island; others, like the celebrated Parnassus or Mount Sinai, are coupled two and two; others are triple, like the mountain des Trois Mamelles in the Isle of

France; others are arranged like the teeth of a comb, as is the case with those near the sources of the Syriam. Some are grouped circularly like the pillars of a labyrinth, like those which crown the summit of the Isle of Bourbon, and in the midst of which rise the Trois Salases in the frozen region of the atmosphere. I have described the last in the "Studies of Nature." Of all the above-mentioned peaks there is not one which does not attract clouds, and which does not form the source of some river. Thus, whenever you see a river, you may take for granted that it has at its source some hydro-electric metal either in the inside or outside; and if you meet with a pointed rock in an arid situation, it is more than probable that a subterraneous spring may be discerned in the neighbourhood. I do not go the length, however, of saying that every peak supplies water to one spring only, or that each spring has its particular peak, although I should be inclined to adopt this opinion; for the pillars of the plain of the Trois Salases in the Isle of Bourbon, which are so numerous and so shrouded in mist, as to create a labyrinth in which persons are apt to lose their way, stand exactly in the highest part of that island which overlooks the sea in a hemispherical shape, and

they constitute the sources of most of the streams that water it.

Another remarkable circumstance in those pillars of the Isle of Bourbon is that, although rocky and steep, they are covered on all sides with a very light soil. One of the academicians who travelled to Peru, I believe Bouguer, took notice of a similar peak in one of our Leeward islands. I am consequently inclined to think that these hydro-electric peaks possess a fossile attraction; and indeed it would otherwise be difficult to explain the manner in which mountains are kept at their height notwithstanding the perpetual tendency of the water which falls on them to carry off a portion of their surface. The attraction just mentioned operates probably on sand and volatile earth, which are scattered through the atmosphere in summer as frequently as showers of rain in winter. This simple explanation suffices to show how grievously those naturalists have been deceived who consider the pyramids at the top of most mountains as the ruins of an ancient world overwhelmed by a deluge.

Hydraulic mountains have, at the bottom of their peaks, reservoirs, or collections of water, which distribute, slowly and uninterruptedly, a

supply to the rivers which flow from them. Without such a precautionary arrangement those rivers would be apt to remain dry in summer, and to overflow in winter. Such reservoirs may be either above or below ground. In the former case they are called lakes, and are frequently met with near hydraulic mountains covered with snow and ice; such as the hyemal mountains of the south, and the reverberating mountains of the north. The inspection of a map of Switzerland, Norway, Lapland, or Canada, will suffice to show how greatly lakes abound in those countries. It was necessary that the basins of these reservoirs should be deep, broad, and open on the surface, in order to receive in spring those sudden and extensive thaws of snow and ice, of which enormous masses are occasionally precipitated into their waters. As we approach the north pole and the immense cupola of ice which crowns it, we find these reservoirs assume the character of seas, as in Europe, the Baltic, the Gulf of Archangel, the Icy Sea; and in America, Hudson's Bay, Baffin's Bay, &c. The latter are covered with floating ice, in masses like mountains, which they send into the ocean during the whole of spring and a great part of summer.

When hydraulic mountains have no lakes or glaciers, they have reservoirs concealed from view

the same way as she has pierced a number of bones in animals to give a passage to the blood and sinews.

By way of conveying some idea of these subterranean aqueducts, I shall say a few words on that which I saw at the Isle of France. A member of council in that quarter, named M. de Chasal, and the Marquis D'Albergati, both very fond of investigations in natural history, having proposed to me to go and see an extraordinary cavern, the origin of which was ascribed to ancient volcanoes, we set out from Port Louis, and after walking an hour and a half through the wood towards the plains of St. Pierre, we observed in the ground an opening similar to the falling in of a vault. A tree growing over this hole had projected five or six of its roots quite across, so as to give it, in some measure, the appearance of a barred entrance into a prison. We went down into it by means of some rocky fragments which had fallen down, and, being preceded by negroes carrying torches, we walked inwards to a distance of more than three hundred yards. This subterraneous passage was about twenty-five feet wide, and in the middle generally seven or eight feet high, but in other places only four or five; indeed in some it was necessary to crawl along in order to make our way forward. This

unequal height was by no means the true height; for the passage was partly filled with red earth, light and ferruginous, as is common in this island. In the places where its natural dimensions continued apparent, its vault was like the handle of a basket, and formed with its sides and its soil only a single piece of rock covered with a varnish of stone, dry, shining, and rugged with ferruginous stalactites, which broke under our feet like icicles. This stony varnish appeared to me in the light of a sap used by nature for the formation and repair of minerals, in the same way as vegetable sap is used to form and repair the bark and wood of trees; or the blood of animals to repair their flesh and bones. This subterraneous passage did not extend across an united rock, but through a tract consisting of a mixture of earth and detached rocks, which, by means of the stony glue just mentioned, were fastened together so as to form a continued piece of mason-work.—Much were it to be wished that art could imitate this glutinous substance; for neither mortar, cement, nor varnish, are to be compared to it for splendour, solidity, and durability, particularly in moist situations. The channel was perfectly dry, owing no doubt to our visit taking place in the dry season; for I was satisfied that water abounded there in the rainy season, from the

stalactites, which are evidently the work of filtrating water, and not of fire. This supposition was confirmed by the quantity of red and fine earth, the proportion of which increased the farther in we went. It was strengthened likewise by our meeting with several kinds of snails and leaves of trees, and particularly by our observing on each side, a few feet from the bottom, horizontal and parallel mouldings, evidently formed by the different levels to which the water had risen. This formed a kind of hydrometer, which pointed out the greater or smaller fall of rain in particular years. This channel is, therefore, the natural aqueduct of a subterraneous stream, and not the ancient bed of a torrent of lava, as some of the inhabitants imagine; although I do not dissent from the opinion of there having formerly been volcanic mountains in the island.

After having treated of the wells, reservoirs, and aqueducts of hydraulic mountains, it remains for me to give an idea of the channels and of the rivers which flow from them, as well as of their mouths, either at their conflux with other rivers, or at their influx into the sea.

The channels of rivers are covered with a muddy or slimy substance, which is deposited, in its course, by even the purest water: this substance prevents the waters from filtrating,

and losing themselves in the ground. It is to avoid this inconvenience that we are in the habit of depositing clay around those basins which are made to contain stagnant waters. Running streams do not need artificial aid, because they perpetually renew their cement; for were they to run along the dryest sands, they would eventually deposit a substance which would stop up the absorbent channels. Nature has made them wind along the sides of mountains, and along plains, in order that the fertility which they bring might be more extensively diffused. Nothing can be more different than the degree of swiftness in the course of rivers, but they will be often observed to run nearly at the pace of a man walking. Nature adopts various expedients to give something like equality to their progress, by accelerating it at one time, and retarding it at another. The conflux of another stream, at right angles, has a tendency to make a partial diminution of rapidity, while a conflux at an acute angle increases the previous velocity. The mouths of rivers will be found to afford an additional exemplification of the laws of harmony. We often meet with one or more islands which break the current and cast it sometimes to the right, sometimes to the left, sheltering it from the winds, and protecting it to a certain extent against the swell of the tempest.

Each part of the gradually sloped hydraulic mountain has vegetables and animals peculiar to itself, and varied in every different latitude. It was on the perpendicular sides of the mountains of the Isle of France, as well as on its Eolian hills, that I found a singular plant, with leaves, in the form of a knotted cord, the roots of which are above, and the head below, the perpetual sport of wind and rain. It is in the fissures of these rocks that many sea-birds take refuge, and among others the tropic bird. In our climates, it is in rocks which are always moist and attracting vapours that we find growing the chelidonium, the parietaria, and the adiantum capillus Veneris, which radiates with its diverging leaves. Among the numerous classes of animals which fix their habitation around them, the wood-pecker of the wall is remarkable. This beautiful bird, the plumage of which is adorned with azure, derives its support from the insects lodged in the fissures. It has claws for creeping along these fissures, and a head fitted, by the suppleness and elasticity of its bones, to make all the efforts necessary to catch its prey between the partitions of the stones.

The reservoirs of hydraulic mountains, or, to use the common term, lakes, contain a number of plants, fish, and birds, not to be found elsewhere. Each lake, like a little sea, has those

that are peculiar to it; among which we may mention, as an example, the *salmo umbla* (*omble chevalier*) of the lake of Geneva. Even subterraneous aqueducts have their vegetables and their animals. I found, in that which I have just described in the Isle of France, a plant of the length of seven or eight feet, of the thickness of the little finger, and surrounded with filaments which fastened it to the vault or top of the channel. This plant had neither leaves nor branches, and would have been exactly like a root had it not come to a point at both ends. It is in places of this description that we sometimes see animals of a hideous shape. According to Chardin, the Persians occasionally take fish of a singular kind, and of an unpleasant shape and colour, in the subterraneous passages made in the bosom of the mountains to convey their waters to the plains. We know that toads and other disgusting reptiles prefer the abode of a gloomy cavern, and that they sometimes get fastened there in such a way as to be covered over with the water from which the stalactites are deposited. The consequence is that these animals become permanently fixed in the rocks, and subsist many years in that situation, deriving their support from fossile substances. It is an undoubted fact

that they have been repeatedly found in the inside of blocks of free-stone and marble.

It is a remarkable circumstance that all animals living in dark situations shrink from the look of man, although it not unfrequently happens that men are obliged to inhabit such spots. It is not merely in quest of gold that individuals consent to pass year after year in a seclusion from the cheerful light of day; necessity often commands a continuance of labour in such spots for other purposes. Men are often obliged to work by the gloomy light of a lamp in excavating quarries, hollowing marl-pits, or in digging wells. Some men go in quest of soft clay under the bed of rivers, covering their head and shoulders with a hood, and having the rest of their body naked. Vanity often leads to attempts of greater danger than those that are prompted by necessity. A humane mind is apt to tremble for the plumber who repairs our roofs and our spires; but in the Isle of France a mason had once the rashness to go up to the salient cube which crowns the peak of the mountain called Peter Booth. By the assistance of some iron stuck into the clefts of the pyramid, he succeeded in getting to its upper part, where, throwing himself backwards, his body being suspended in the air, he succeeded,

by means of the irons in question, in putting his feet on that base on which none but birds had till then rested, and showed himself to the affrighted islanders on a pedestal the top of which is lost in the clouds. His name ought to have been inscribed there, were not the remembrance of rash and useless actions deservedly consigned to oblivion. Boldness has always the effect of exciting surprise in mankind; but it interests them only when it is productive of a beneficial consequence.

Having given a sketch of hydraulic mountains of gradual slope, we shall now make a few remarks on such as are amphitheatrical. Of these there are two kinds; one, like the preceding, rising in a pyramidical form, and divided by stages like a king at chess; the other cut in a manner, by successive levels throughout their circumference, like the steps of a stair.

Pyramidical mountains in an amphitheatrical shape are of frequent occurrence in small islands: a number of them may be observed on minute charts of the islands of the torrid zone, such as we have in Captain Cook's Voyages. Some of these mountains exhibit no less than five or six distinct stages or divisions of ascent. This is a proof of the wise arrangement of Nature: for if a river descending from the top of these mountains were to fall into the sea by a continued

slope, its waters would be in danger of falling very low; whereas when it falls from an amphitheatrical tract it is rapid only at cascades, and it afterwards flows gently along a level. Such is the effect of its perpendicular falls in lessening its swiftness that, however strong its course may be above the fall, it is almost imperceptible below it.

Hydraulic mountains in an amphitheatrical form are common in high-lying countries like Switzerland, and wherever such occur we may reckon on finding cataracts. It often happens that these mountains have, on one side, a gradual slope, and on the other an amphitheatrical form. By means of them Nature sometimes sends forth two streams from the same peak to run towards two seas situated in very different directions. Notwithstanding the difference in their degree of distance, their waters may arrive at their respective *embouchures* with nearly equal swiftness on the whole; the one whose course is longer holding its way through a gradual slope, while the other descends from an amphitheatre. This is exemplified frequently in the Alps, the Cordilleras, and in all the mountains situated between two seas at the extremity of an island and a continent.

Another remarkable circumstance is that all

cataracts are fortified with large rocks. I know not whether the neighbouring tracts have in general rocks or not on the same level; but they are evidently necessary at the spot where the water is precipitated, to prevent it from carrying off the soil. Without such a fortification, the duration of which must be surprising, the water would clear an oblique passage for itself, and would run along with the rapidity of a torrent. The cataracts of a river are consequently by no means proofs that the country through which it runs has been at no distant date overflowed by the sea, as has been alleged by some celebrated writers in speaking of the rivers of the new world. Cataracts are very common in the mountains of our own hemisphere, although, according to the system of the writers in question, our mountains were the first part of the earth relieved from the pressure of super-incumbent water. We see moreover a number of cataracts even in the plains of Asia, Africa, and Europe. The Rhine, the Danube, the Wolga, the Senegal, and the far-famed Nile, have, as well as other rivers of long-inhabited countries, cataracts in different parts of their course, like those of the thinly-peopled regions of America. So far therefore from being a proof of disorders in Nature, cataracts may be

safely considered as an evidence of the wisdom of her plans.

Hydraulic mountains with flat tops have not so much an absolute as a relative degree of height; they are mountains only by means of their sides, for they are level at their summits as at their foundation, and prove the fallacy of the ancient axiom, that there is no such a thing as a mountain without a valley. They are different sections of the same ground which rises by degrees like those of an amphitheatre. Nature doubtless made this disposition to counterbalance the slope of several parts of the Continent towards the sea, to preserve them from the sweeping effect of rain, and to keep their waters on them for a season by dividing their soil into stages, in the way practised by the Indians and the Chinese in the slopes of their mountains; a practice evidently derived from the observation of such mountains, and directed towards the same end. How should we refuse to account for the operations of Nature by supposing them guided by that reflection which we so willingly bring forward to explain the actions of man, although man has never imagined or performed any thing indicative of great judgment, except when imitating Nature.

I have remarked, even in France, this gradual

slope of the ground from Paris to the coast of Normandy. On passing by Evreux you travel across extensive plains, at the end of which you meet with a descent; other plains succeed this descent, and continue all the way to the extensive meadows of Lower Normandy. Land disposed amphitheatrically is of frequent occurrence in Africa, America, and particularly in the North of Europe. M. Chappe, the astronomer, whom I saw only for an instant, and whom I have regretted my whole life long, drew, in order to render his journey more instructive, a sketch in profile of the different heights from Paris to Siberia by means of a barometer which he carried in his post-chaise. But you have no occasion for an instrument to ascertain the height of different situations, for you will perceive them in a map by the direction of rivers, and their cataracts will point out those parts where the land rises in an amphitheatre. I found most of the rivers of Russian Finland abound with cataracts; some oblique, others perpendicular. Lakes extend there from north to south like the Cordilleras, and communicate with each other, having in general their final discharges into the Baltic; some, but comparatively few, fall into the icy sea. The soil over which they run in that quarter seems nearly on a level with that sea which

has no mountains along its shore; a new argument, in my opinion, that the earth becomes lengthened towards the north pole.

Hydraulic mountains with flat tops offer, as may be well imagined, vast amphitheatres to vegetation, by affording it a support, a shelter, and a supply of water. In its rivers are to be found fish, which show great dexterity in mounting over cataracts. The bleakest summits of these mountains have animals and vegetable products of a description peculiar to themselves. It is on their rugged tops, abounding generally in iron, that we find the larch so much used in forges, where it is found to accelerate greatly the melting of metals, its trunk and branches being covered with agarics and inflammable moss. It is in rivers, having their sources there, that the salmon takes a pleasure in swimming upwards, and in leaping at a single vault over a resounding water-fall. He is perhaps attracted up the stream by the seeds of the larches and firs which grow at a distance up the mountain; and this is perhaps the cause why this fish prefers the rivers of the North to those of the Mediterranean, in which trees of that description are very rare. The wild goat is met with only on the steep summits of the Alps, where he browses on plants unknown to the people of the country. It was

not for this light and indocile quadruped that Nature rounded the hills and smoothed the plains of Elis: to outstrip other animals in swiftness, he needs not either the empty applause or the unfeeling urgency of man; for no obstacle can stop him when the calls of love push him forward. If the winds bring him the scent of a female on the other side of a bog, or ravine, it is in vain that the torrents roar at his feet; Nature has refused him wings, but Cupid lends him his bow; he exposes himself on the branches of a shrub, and clears, by a single effort, the frightful precipice.

All the mountains that I have hitherto described would very soon experience a diminution of size by the effect of rain, snow, torrents, and the lapse of time, had not Nature made provision for their progressive repair. The Alps are kept up by quantities of sand borne thither from the sea-shore, in the same way as their rivers and glaciers are fed by the arrival of clouds. It is from the perpetual motion of the waves of the ocean, which night and day roll over and wear the rocks and pebbles on its banks, that the long sandy zone which covers the shore is formed. It is from that zone, which surrounds all islands and all continents, that the winds carry incessantly clouds of such light and subtile dust, as

to admit of being transported into the most remote parts of the earth. They deposit, by the way, in different spots, reservoirs of this airy material, in the same manner as the aquatic clouds, proceeding from the same quarter, feed, by the rain which they send down, marshes, lakes, and even mediterranean seas. This dust is so volatile that it rises to the summits of the loftiest mountains, and is fixed on their hydro-electric peaks, to which it gives an earthy covering. From these it exudes into all hollow places, which it fills with stalactites, and covers up their outward clefts, affording nourishment to the lofty trees which often crown them. This dust being produced from the sea-sand, which is frequently filled with particles of iron, and sometimes of gold, being pounded by the sea, warmed by the sun, and carried along by the wind, contains the primary elements of vegetation. It is this which covers our furniture, and is so volatile as to hover incessantly throughout our apartments, particularly in such as are not inhabited. It deposits layers of vegetable earth on the top of our walls, and even on the cornices of our towers, which, by means of it, are covered with plants of all colours, with shrubs, and sometimes with stately trees. The sea-sand, which engenders it, is itself so subtile, and produced in such a quantity on the

shore, as to render the neighbourhood uninhabitable in situations where the winds are violent; this is one of the great inconveniences of the Cape of Good Hope, where the town is surrounded by sandy tracts and mountains of gravel. When the volatile sand which covers them is agitated by the wind, it not only prevents the inhabitants from walking in the streets, but even finds its way into their houses, although the windows have double sashes, and the doors are shut with the greatest closeness; still it enters by the key-holes, and by the smallest fissures, in such a quantity that it is felt cracking in the teeth in every mouthful, as I have experienced myself. Cornelius le Bruin makes the same remark on the sand-storms on the borders of the Caspian; and Pococke relates that Egypt is exposed to great inconvenience from that cause. "Sand-storms," he observes, "intercept the sun's light, and the sand thrown up is so thick as to prevent the traveller from seeing to the distance of a quarter of a mile. The dust penetrates into the closest rooms, into beds, and even into cupboards; so that the Turks, to give an idea of its subtilty, are in the habit of saying that 'it makes its way through an egg-shell.'" Nor is the interior of continents exempted from sand-storms. I have already no-

ticed those of Pekin, where the inhabitants are obliged to ride out with a crape or veil over their eyes; and most of my readers will remember those which overwhelmed the formidable army of Cambyses.

These volatile sands enter so frequently into the plans of Nature, that she has, in a manner, palisadoed the eyes of men and quadrupeds in order to protect them from the annoyance to which they would otherwise be exposed. If this flying dust is attended with inconvenience, it must, on the other hand, be allowed to be very useful to vegetation, and in forming, on the sea-side, those downs or sand-hills which serve as natural barriers against the waters. These downs are the smallest of the class of littoral hills or mountains, of which there are two kinds; the sandy, and those composed of rocks or stone. Each kind may be subdivided into concave and convex, meaning, by the former, such as extend into the bed of the sea; by the latter, those which rise above the surface of the ground. Under the former I class sand-banks of all descriptions, the origin of both being the same; for downs are small mountains of sand, formed in the first instance by the action of the water, and appearing like sand-banks deposited by currents. They are generally formed by the oppo-

sition of two currents, and are consequently very frequent at the mouth of rivers. From the same cause they are of great extent in the neighbourhood of the equator, that being the quarter where the two immense currents of the ocean, formed by the alternate melting of the ice at either pole, meet and make deposits of vast magnitude. The sand-banks of New Holland, which render the access of that coast a point of such difficulty, are formed by the wrecks of matter in either hemisphere, and particularly in our own. To these may be added the dissolution of the stony materials, of which such myriads of fish form their shells, and with which, as with a rampart, the madrepores surround most of the islands of the torrid zone. These maritime fortifications are in a state of perpetual increase, and whole islands in the South Sea, according to Captain Cook, owe their origin to them. The sea wears away incessantly the hardest rocks, and increases the size of the sand-banks by the demolished materials. These sand-banks are a kind of moveable dike, which may be said to resist by yielding; they are made to augment the height of the strand by spring-tides, and particularly by storms which throw them more and more towards the land. Of these I have been a witness in a number of places, and particularly

at Ascension Island, at Turtle Bay, where the sand extends half a mile inland, and has been raised more than twenty feet above the level of the sea. This has not been the work of tides, which never attain such a height in the torrid zone; it is the work of hurricanes, the violence of which is such as to throw enormous banks of pebbles more than fifty yards inland, as I have witnessed in the isles of France and Bourbon: sand is carried by them a great way farther.

Sea-sand, when once carried to a certain distance from the shore, is seldom blown back into the water, but accumulates into sand-hills, or downs, a name derived from the Celtic *dun*. Hence the origin of Dunkirk, or "church among the downs." The form of these sand-hills shows that, as I have already remarked, the course of the wind is, to a considerable degree, from above to below; and as the blast is frequently from the sea, it sometimes happens, as was the case at Saintonge, that the sand-hills are blown inward so as to cover up entire villages. On the other hand, we are not without examples of the sea undermining sand-hills; the town of Sables d'Olone having been, thirty years ago, on the point of destruction by sea currents, which had carried off its strand, its gardens, and even one of its streets. It was in vain to attempt defending

it by dikes, piles, or walls; the inhabitants saw the daily progress of the water, and looked forward to nothing short of the destruction of their town. However, a skilful engineer, of the name of Lamandé, found at last the means of making the sea restore her late acquisitions. Having observed that the destroying current first struck against a part of the coast, from which it was driven directly on the town, he constructed, at the angle where this took place, a dike which turned the current obliquely out of its direction, so that in the sequel, so far from undermining the town, it gave it back, in the the course of a twelve-month, a greater portion of sandy and pebbly materials than it had taken away. Thus did the knowledge of a man, attentive to the laws of Nature, save a flourishing town from the ravages of the sea, and render the waves instrumental in repairing the damage they had caused. He accomplished his object, not by directly opposing their violence, but by turning it in a different direction, exemplifying the truth that Nature can be opposed only by Nature, a maxim equally applicable in politics and morals as in physics. The inhabitants of Sables d'Olone look on this engineer as their guardian angel; and one of them, having no children or persons dependant on his pecuniary assistance, bequeathed him

2000*l.* as a recompense for the service thus rendered. I have a pleasure in recording this act of generosity towards one of my former friends, whose ability fully entitled him to the public gratitude.

Sand-hills are the best barriers that can be opposed to the rage of the ocean. The waves dash along their extensive slopes without meeting resistance, and often augment this bulwark by tempests which would destroy the strongest jetties. Nature has strengthened them with a variety of vegetables according to the climate. In the sea-sand of the torrid zone, she has planted the supple mangrove as a kind of floating dike, and the cocoa-trees, which interweave their roots so as to form a solid mass. She has spread on the surface of these sands a number of animals, such as crabs, the pagurus-bernhardus, tortoises, as well as a crowd of sea-birds, which are accustomed to exist only on sandy soils. It is there also that we find occasionally wandering tribes in a state of nature, who find the means of subsistence by fishing and hunting. In our climate, likewise, the downs have their vegetables and their animals. It is on them that we find growing the *arundo arenaria,* or bent, squills, and the most fragrant species of thyme. The rabbits, so well described by La Fontaine, and whose lot

was envied by the unfortunate Rousseau, are fond of scooping out, in them, their long and secluded retreats. The instinct of these peaceable animals in excavating the ground sufficiently shows that they are the natural inhabitants of downs. Those of Cabourg, on the coast of Lower Normandy, are for various reasons the most esteemed in our climates. The Dutch, menaced by the irruption of the sea, consider their sand-hills as their best dikes; they take a great deal of pains to keep them up, and repair occasional damage by means of bundles of rushes, which they drive in from space to space into the parts exposed to the action of the water. They sow here likewise the *arundo arenaria*, and they put oak-planks, with surprising perseverance, on some part of their sand-hills, in spite of repeated injuries from the sea.

Littoral mountains, composed of stone, are, like sand-hills, of two descriptions: I mean concave and convex. The concave are excavated by the waters of the sea; some of them, like the sub-marine rocks, being below the water, while others, like the cliffs, rise above it. The convex kind consist of rocky masses, or eminences, elevated above the surface of the ground.

Sub-marine rocks are likewise of two kinds: some are at present in a course of formation by the action of the sea in petrifying their bases, or

accumulating coarse sand; while others are the product of former ages, as in the case of the cliffs, which are at present in a state of gradual decomposition. Among sub-marine rocks we are to reckon the great bank of Newfoundland, which is of solid rock, as has been ascertained by sounding, and around which the sea is of so great a depth as very seldom to admit of being fathomed. We are to add to the same class the great bank which borders the west coast of Africa, and with these we ought perhaps to include the bottom of the sea in many places, as, on being sounded, it presents nothing but a bed of rock covered here and there with mud, sand, and broken shells. Be this as it may, a number of sub-marine rocks are visible along the shores of the ocean in all directions, and constitute the defence of the land against the swell of the waves. Such are the rocky pillars which extend along the coast of Norway to a distance of 300 leagues, and the still more extensive rocks which run along the Brazil shore. These maritime bulwarks are frequently little elevated above the level of the water; but they often extend to a surprising degree of depth. Two ranges may be added to those just mentioned; the rocky chain surrounding the clusters of the Maldive Islands, and the accumulations of madrepores which encircle, like

a girdle, a number of islands between the tropics. All these natural dikes bear the marks of admirable skill in their construction; for, however hard may be their component parts, they are open at the mouths of rivers, not always in the direct course of the stream, but in the manner most suitable to the influx of the waters with a view to the sea-currents. As it is on such spots that the alluvial deposits of the sea and land take place, it is there likewise that we find a prodigious variety of fuci, algæ, coralloids, spongy substances, worms, shells, fishes, amphibious animals, and birds, many of which are still without names in the languages of Europe. I may almost venture to say that the natural history of a submarine rock, situated between the tropics, could not be comprised in a cabinet of considerable extent, were we to confine our collection to two individuals, the male and the female of each species, which, in the course of the twelve months, visit or inhabit the spot in question. I have crossed in a canoe many of the sand-banks of the Isle of France, and have observed that they were paved with madrepores in almost as great a variety as the grass in our meadows. These madrepores are filled with zoophytes, crabs, and shells of every description, some of which are said to be of such a size as to form a tolerable

load for a horse. The soil on which they are deposited is itself of madrepore origin, and its layers are easily converted into lime. When the sea retires, and uncovers at low water a part of the foundation of this hydraulic architecture, it is then we have an opportunity of being convinced that a rock is not the work of chance; since, on its existence, depends that of a number of vegetating and living beings expressly organized for such spots. The lepas, for example, is a pyramidical shell-fish fastened to a rock, at which it sucks, and on which its existence is so dependant that it dies on being detached from it. The oyster, in the Isle of France, fastens to the uneven parts of the rocks in such a manner that its shelly covering becomes adapted to the openings, and can be removed only by breaking off a piece of the rock. When first I saw a basket of oysters in that island, I thought them a basket of stones, and in fact it is necessary to use a hammer and chisel both in fishing and opening them: their quality is excellent. I have seen, at Malta and at Toulon, a kind of muscle called *dail*, which fixes itself and lives in the inside of blocks of calcareous stones in the bottom of the sea, and which is not to be found any where else. It is no easy matter to account for the manner in which the *dail* finds its way thither, since

is no visible aperture in these stones, and it is necessary to break them open by main force: it is really a dainty for the palate. It is not for me to relate what I have seen in this way, but for the Patagonians, for the inhabitants of the stormy Orkneys, of the Kurile Islands, of the straits of Jesso, discovered by the unfortunate La Peyrouse, and for that crowd of wandering tribes who, without task or cultivation, find in the varied products of the sea-shore a more abundant supply than many of their civilized brethren are able to extract from the land.

The ocean is, as we have already remarked, both the cradle and the grave of the earth; it is the great receptacle of the remains of substances of all kinds, and I cannot help thinking that it is to their dissolution that it owes the pitch and salt with which its waters are impregnated. However limpid the waters of the ocean appear to us, they are discoloured in great storms in all situations that admit of sounding. On putting sea-water into a glass at the time of a storm, we observed grains of sand sink to the bottom, as I have myself seen at the distance of 140 miles from land, in a westerly direction from the coast of France. In fact, this is one of the methods adopted by seafaring men to discover the distance from land in mist and bad weather, when

sounding is impracticable. Soundings are generally taken with a piece of lead, of more or less weight, but frequently from sixty to eighty pounds. It is fastened to a rope of a hundred and fifty or two hundred fathoms' length, and dropped down to the bottom of the water. On the lower part of this lead there is a round cavity about the size of a salt-cellar, which is filled with a prominent lump of tallow; this tallow is crushed by the weight of the lead, and becomes mixed with the sand and mud of the bottom on which it rests. An opinion may be formed of the distance of the vessel from the coast by looking at this sand and mud, of which the consistence and colour vary according to vicinity or remoteness from land. The art of sounding has enabled naval geographers to make very good charts of banks and shoals that are perpetually under water. In this it appears to me that naval men surpass astronomers; for they measure invisible distances at the bottom of the sea with greater accuracy than the others discover in regard to inaccessible distances in the heavens. It is by dint of sounding that we have been enabled to ascertain the outline and height of submarine banks on our coasts, and even on the Bank of Newfoundland, which is more than two hundred and thirty leagues in length.

The concave littoral mountains which rise above the surface of the water, along the coast, are called cliffs, and are in fact nothing else than steep banks of a greater or less degree of elevation, but generally on a level with the adjacent ground. They all bear the marks of being worn away and shaped by the action of water, and they consist of minerals of all descriptions. Some are of free-stone, like the high shores of Malta; others of lava, like those of Ascension Island. The latter advance their perforated tops above the sea, which, striking below with its rolling waves, casts the spray through their holes in surprising quantity. I have seen the coast of that island covered with it sometimes for a mile in extent. It is, no doubt, to the existence of some long cavern into which the sea-water rushes, that we should ascribe a spring of salt water which flows at intervals in the island of Malta, at a considerable distance inland. There are several such springs, or issues of heated water, in the neighbourhood of the volcano of Hecla, in Iceland.

The cliffs of Normandy consist of alternate layers of white marble and black flint, arranged horizontally like the stones of a public building. They are frequently eighty or a hundred feet in height, and are evidently the work of the ocean, being filled with shell-fish, and, what is more

surprising, containing occasionally the largest shells of India, such as the *tridacna gigas*. These, according to my theory, have been formed in a remote age in the Indian ocean, and are now in a progress towards demolition by the waves of the Atlantic. It has been calculated that the sea wears them away to the extent of a fathom annually; a diminution which, I think, might be stopped by cutting these cliffs in long slopes from top to bottom. When cast into such a shape, the tide would flow farther in, and no longer vent its fury on the foundation. It would even be sufficient to cut the lower part into a gentle slope, to a level with the water at high tides, leaving the upper part perpendicular, and reserving beautiful sites for houses which would enjoy both a land and sea view. In a future age we may see as much cleared away in different situations as will afford, at particular places, a dock for small vessels, or an opening for a bathing-house. Buildings might be erected very near the sea without danger, when the waves were allowed to glide along the slope without resistance, and a mass of pebbles would no longer be carried by the winds fifty miles eastward to obstruct the port of Havre, as is the case at present to the great injury of that town.

The idea of these littoral slopes does not ori-

ginate with me; it is derived from the works of Nature. Examples in point are to be found in most littoral mountains, and are found conducive both to their preservation and to the use of the amphibious animals which frequent these spots. Slopes of this description occur very frequently on the shores of the North, among the rocks which border Greenland, Spitzbergen, and Hudson's Bay. It is there that we find a number of sea-calves, morses, seals, and sea-horses, which make choice of such situations either to come out of the water and go ashore, or to plunge into the sea at the sight of a pursuer. These strands are of solid rock, of a gentle slope, and extremely slippery, being perpetually lubricated by the glutinous substance of the skin of the animals we have mentioned. They would find a difficulty in creeping along it, had not Nature supplied most of them with large curved teeth, which enable them to take a fast hold. Those slopes serve likewise for receptacles for masses of ice rolling down from the northern glaciers into the waves of the ocean. The uncivilized inhabitants of this forbidding region follow the example of amphibious animals, and consider such spots a fit station for their petty barks.

Littoral mountains, when higher than the adjacent ground, are in general of rock, and are frequently found in situations where the seas are

tempestuous. This is the case with the Orkney Islands, beaten as they are incessantly by the waves of the Caledonian Ocean. These islands, placed at the conflux and in the eddies of the great current of the Atlantic, when its summer supply of water descends from the pole, and placed likewise amidst its lateral counter-currents, are in general formed of high pyramidical rocks cut into precipices. The tempests of the air reign at their summits, and those of the sea at their bases; but they contain within their valleys a shelter favourable to plants, animals, and even to men. Had these northern islands, exposed as they are to the wind, consisted of elevated levels with steep sides, no vegetable could have grown on them.

There would be no end to my descriptions were I to attempt enumerating the plants and animals which are found on littoral mountains. The species of moss and of sea-birds are as many and as various in the clefts of the rocks above water, as the fuci and shell-fish in the cavities of those that are under the deep. The uncivilized inhabitants of the neighbourhood find in this situation not only the means of support, but objects of luxury for the ladies of Europe. The Indian plunges into the bottom of the sea in quest of pearls, while the Scotish Highlander, suspended from the top of a rock, contrives to rob the eider-duck of the down of its nest.

Terrestrial Harmonies of the Earth.

THE earth seems to have mountains which are peculiar to it, and which form, in a great degree, the principal elevations of its circumference. Such are the mountains of granite, of which there are two long chains on the surface of the globe, one of which extends from north to south in America, from Baffin's Bay all the way to Cape Horn. It may be considered as taking its rise in the torrid zone, where it forms the lofty Cordilleras covered with perpetual snow; it extends its progress along several ranges towards the east, and surrounds, by means of them, the bays, the mediterranean waters, and the gulfs of the Atlantic Ocean, whose vapours it receives, and whose rivers it feeds. The other great chain of mountains of granite is in our own hemisphere, and runs from west to east, beginning at Mount Atlas, on the borders of the Atlantic Ocean, and extending all the way to Kamtschatka. It consists of Mount Caucasus, Imaus, Taurus, Ararat, the mountains of Thibet, &c. and stretches out to the north and south subordinate chains, which embrace on one side the Mediterranean and Caspian Seas, on the other the Red Sea with the gulf of Arabia, Persia, Bengal, and Cochin-

China. It receives on its respective sides the vapours of the Indian and Icy Oceans, and extracts from them a supply for the mighty rivers which water Africa and Asia. In addition, an extensive range of granite runs along the polar regions of the North, discovering itself in successive elevations throughout Finland, Sweden and Lapland; rising to an Alpine height in the littoral mountains of Norway; and in the shape of pyramids in those of Spitzbergen. Granite seems to form, at the bottom of the waters, a kind of bed for the Icy Sea. It is in that northern region that the globe, naturally higher and having its soil washed off by the ice and currents which flow from it, lays open its shell of granite, in the same way as mountains display their tops rendered bare by similar causes. Moreover, a horizontal line, proceeding from the lower part of the frozen regions of the pole, would pass by the base of the foundation of the glaciers of the Alps at the height of half a league, and those of the glaciers of the Cordilleras at the height of a league; affording, in my opinion, a proof that their foundations are on the same level, and that the poles are elevated above the surface of the ocean.

These mountains combine the harmonies of all the others, of which they are in some degree the

nucleus. Hence the cause of the granite appearing sometimes at the bottom and sometimes at the top, notwithstanding the theories of naturalists, who, after dividing the Alps into primitive granite and secondary calcareous, are much surprised to find blocks of granite under strata of calcareous stone. In the drawings of the victories of the Chinese over the Tartars, there are to be seen mamillary mountains *(montagnes à mamelons)*, surmounted by rocks in horizontal layers. The chain of the Cordilleras consists of mountains of every description; some of the reverberating form, others like a parasol; some volcanic, others hyemal, hydraulic, Eolian, or littoral.

The form of these mountains, and indeed of mountains of all descriptions, is varied in an almost infinite degree. Independently of their utility, they constitute a great ornament to a landscape, for nothing would be more monotonous than a globe of earth completely round. It would contain neither rivers nor streams, or, to speak more properly, it would be over-run by water in all directions, for the plain reason that water could find its level in every part of the circumference. Mountains are then necessary to establish the harmonies of Nature: by means of them the winds blow, waters roll, plants vegetate, and animals are kept in motion; they are the

keys of the great organ of life, which are successively struck by the solar rays. It is customary to speak with high praise of views taken from the summit of mountains, but I find a still greater charm in those taken from the bottom of valleys; the latter are preferred by painters, and with reason. Looking from above we see little but the bottom of valleys covered with fogs, while on looking upwards we behold mountains crowned with clouds, and enlivened by the sun's rays. The former show us the earth, the latter the heavens; the finest prospects of nature are to be found on the ground, and lie within our reach.

Before entering into any detail on so comprehensive a subject, we shall attempt giving an idea of the manner in which mountains appear to have been formed. There is no doubt that volcanic mountains owe their origin to fire; sandy downs, to winds; and calcareous littoral mountains, to the operation of water. All the concentric layers in the earth appear to have been deposited by the waters of the ocean, and the latter would, no doubt, have made the surface of the globe perfectly smooth, had not their operation been counteracted by primordial causes. By what means would those fine valleys which diversify the globe have been excavated? By running water it may be replied; but running waters have necessarily

their source in high grounds, and it would be a *petitio principii* to say that high grounds must in like manner be produced by the action of water. Mountains have then been instrumental in establishing the first organization of the globe according to plans conceived by the wisdom of the Divinity. God raised them, not after the manner of man with machines, but by means of elements and by the general laws of Nature, which are instruments for the execution of his will. Were it permitted to a feeble mortal to follow the steps of heavenly wisdom, I would venture to say that the power of attraction alone is sufficient to organize the earth in the way we now see it. By this I mean, first a central attraction towards the middle of the earth, which is the cause of the gravity of all the bodies at its surface, and of the rotundity of the globe. I next admit a partial attraction, proceeding perhaps from the former, and discovering itself by the tendency of the magnet toward the north pole, while in the summits of lofty mountains it is displayed in different degrees of electricity and magnetism. The latter appear to have their foundations in nuclei of granite, and their foci in the metals which are sometimes found in them, such as iron, copper, &c. I am now supposing that the earth being in a state of softness, as appears probable

from the different materials which enter into the composition of granite, was exposed both to the influence of its central attraction which rounded it into a sphere, and to the influence of solar attraction, which gave it first a circular impulse around that orb, and afterwards a rotatory one on its own axis. In this rotatory motion the solar attraction probably acted on partial attractions from the earth, so as to raise into mountains various parts of its circumference, the degree of heat differing according to the degree of attraction.

To form an idea of the varied curves into which mountains have been shaped by partial attractions of the sun, suspend a thread on the parallel upright bars supporting a pane of glass, so that the length of the thread may be to the distance between the bars, as one and a half to one; it will form a curve nearly semi-circular. If you move down one of its ends along one of the upright bars, until it comes into a straight line, it will describe successively on the pane of glass a number of inverted curves, which will represent the curves of mountains of all kinds, from the hemispherical to those which are formed slightly elliptical. In this hypothesis, the earth, which attracts the thread, acts on all its parts; but I suppose terrestrial attraction to be suspended to a single point, for example, the middle of the

thread. Now, if we put there a grain of lead, the thread instead of describing a curve, will describe the two sides of a triangle, the inverted top of which will be the point of attraction. The vertex of this triangle will be more acute in proportion as the base is narrowed, and more obtuse as the base is extended. The attraction of the earth on the thread represents that of the sun on the partial attractions of the circumference of the earth when in a soft state. In situations where there was only one point of attraction, there may have been formed a mountain of which the profile was a triangle, a pyramid, or even a peak, as indeed is the case with littoral mountains in general. The focus of their attraction appears to be at their summit, and is incessantly surrounded with clouds. These maritime mountains have a sharp and rude look, like the tempestuous elements near which they are situated. But when partial attractions have operated on all the extent of the mountain, they form very agreeable and finely diversified curves, such as are in general those of the hills, the slopes, and the valleys, in the interior of islands and continents.

I must add that I am far from attaching consequence to these observations. They may perhaps serve to suggest to us a sufficiently natural idea of the manner in which the formation of

mountains has taken place, as they trace it to the influence of solar attraction; an influence which serves likewise to explain the motion of the globe. A similar mode of reasoning may afford a satisfactory explanation of the origin of flowers, fruits, the muscles of animals, and particularly of the shape of the human body, which contains curves of a variety hardly to be paralleled in any other work of Nature. My notion is that it is a focus of solar attraction which extends, in the shape of hemispherical shells, into the five petals of the rose, in the shape of an ovoid in the tulip, and of a spheroid in the apple. Each seed has its particular form, which is called into existence by solar influence. The human fœtus has also its form, subject, in like manner, to the influence of the orbs of day and night. All its bones and muscles are in harmony in different periods of months, years, and cycles, receiving a progressive increase at the times of birth, dentition, puberty, and virility. An expansive attraction extends our muscles in the places which stand most in need of strength and beauty. In the head, for example, we find elliptic cheeks admirably calculated to display the smiles and modesty of young girls; in the maternal bosom, breasts adapted to give suck to children; in the body of a robust man, whose duty it is to rear and protect

them, Herculean muscles in the legs, arms, and shoulders, combined in a variety of forms. On contemplating these, you are disposed to say that the son of earth and of heaven is formed, like his mother, of hills and mountains.

Although all forms of bodies are comprised in the sphere, Nature does not generate them like man by means of a compass; but makes use in their formation of the positive and negative qualities of her attraction, which she directs towards each body in a variety of modifications subordinate to the universal law of their utility. The cone, from which we derive the principal curves known under the name of conic sections, is itself generated in the sphere by the circular revolution of the extremity of one of its radii around the radius which serves it as an axis. A number of new curves might be produced from vases of a spherical, conical, elliptic, parabolical, hyperbolical, or other shapes. On making them half full of water, and inclining them to one side, the contour of the water would exhibit a number of different curves generated by the sphere, and owing their formation to the attractive power of the earth in putting water on a level. It is by means of water, and the intersections of its different levels, that so many figures regularly irregular (if I may be permitted the expression) are formed

in the interior of marbles. The finest curves of all, however, are to be seen in the human body, where they are collected and harmonized in perfect concert. To acquire a proper knowledge of them we ought to follow the plan adopted, according to Winckelman, by celebrated Italian artists in copying the models of antiquity. These artists were in the habit of putting the models in water, the different heights of which exhibited the various sections of the statues with the greatest precision. It admits of no doubt that there are, from the sole of our feet to the crown of our heads, a succession of curves, all different from each other; they will all vary if we incline the figure only a single degree, and still more if we increase this inclination from one degree to another. In fact we shall find a difference of profile at every stage, until the figure be an horizontal position. These profiles may be made to amount to no less than 5,400 for an inclined figure, and if you join them to those given by a horizontal and those given by a perpendicular position, you will be satisfied that no landscape contains aspects of so great variety as the human figure. Add to these the farther differences produced by diversity of constitution, age, and sex, and you will acknowledge that the varieties of beauty given by Nature to

man are inexhaustible. Include in your calculation not merely individuals, but groups of families, tribes, and nations, and what an endless variety of shapes shall we find in addition to those with which we are already acquainted? For my part, my knowledge in these points is so limited that I am unable to explain in what manner is formed the luminous reflection of two circular parts shaped like a heart, which appears at the bottom of a cylindrical coffee-cup when it is inclined to one side. This reflection comes, I am aware, from the concave part which receives the light, but in what manner is it decomposed on the bottom into two portions of a circle which touch each other? I leave this to be solved by persons better acquainted with the science.

Such are the principal characteristics which I have collected in regard to the different kinds of elementary mountains with which I happen to be acquainted. The number would have been greater had my range of observation been wider; but at the time of life at which my travels took place, I had no idea of the existence of a harmonic order in sands and rocks. I had adopted a notion from books that there was on earth no other architect than man, and no order of architecture except the five enumerated in scientific works. I imagined that he who had ordered the

world had reserved his superintending agency for the heavenly bodies; that he had abandoned our terrestrial globe to the elements, and its products to our disputes. But I have since seen that mountains are shaped according to their latitudes, not only with a view to the elements, but with a view to particular kinds of vegetables and animals, the original species of which are to be found only in such situations. The steepest situation has an appropriate quadruped, and where there is water an appropriate fish; vegetables are planted there for the purpose of attracting them by their fruits, or by the insects which feed on them. Nature has placed the fir on the amphitheatrical mountains of Scotland and Finland, while she has taught the marmot, the inhabitant of rocks, to creep towards it, and the salmon to spring in their rivers and cataracts. By way of diversifying her works, she has crowned with the same tree the lofty levels of New Spain, and has provided it there with a tenant in the flying squirrel. She has clothed with green the slopes of the Æolian mountains in the Antilles, and she has created, to roll there, the armadillo surrounded by belts. She has suspended the ape on the waving liana, hanging down from the sides of the shady mountains of the torrid zone, and she has placed the goat near the summit of the Alps. Every rock

has its vegetables, and every precipice its inhabitant. The salmon leaps by means of his loins, the marmot by means of his feet, the flying squirrel with his arms, the armadillo with his back, the ape with his tail, and the goat with his horns.

Elementary mountains offer farther characteristics in harmony with man. Some of the hydraulic kind look at a distance not unlike the human figure; such, in the Isle of France, is the peak of Peter Booth, which, surmounted by a capital and surrounded by clouds, affords no bad portrait of a female dressed in a flowing robe. Such, in the same island, is the summit of the mountain *du Pouce*, which seemed to me to represent the head of Enceladus looking up towards heaven. I cannot help imagining that it was the sight of figures of this description which gave Homer the idea of relating that the ship of Ulysses was changed into a rock on arriving at a port in Ithaca, because there is, at the entrance of the port in question, a rock which, at a distance, looks like a ship under sail. It serves as a mark to seamen to guide them on their way; while other rocks warn them to avoid a dangerous quarter by their mournful and forbidding appearance. Such is the rock of Scylla, which, being black, and covered with foaming and

howling billows, suggested to Homer the fiction of a woman surrounded by devouring dogs. Ætna, with its fire, its smoke, its lava, and its tremendous sounds, suggested to Virgil the image of the giant Enceladus, struck with lightning by Jupiter, and making all Sicily shake with his convulsions. Other mountains, placed in the interior of continents, presented to the ancients an image of the palaces of the muses, or of the abode of the gods, by their majestic backs, their pyramidal points, and their rich displays of light when the solar rays struck on the clouds collected above them. Such was Parnassus in Phocis, and Olympus in Sicily. Such intellectual sensations are, no doubt, destined to raise the human mind towards heaven; for they have captivated, in all times and in all countries, the imagination of the bulk of mankind. It is the influence of such impressions that leads savages to make offerings to mountains which they believe to be inhabited by spirits, and it is a similar impression which has led so many civilized nations to construct temples and chapels on their summits. It was this which led the Jews to sacrifice in high places, notwithstanding the opposition of their prophets, who told them that it was not there that the Eternal had fixed his abode, and that the earth, in all its beauty, was hardly worthy

to be his footstool. These speculations, however, are of too high a character; let us quit lofty mountains, and be content to descend into humble valleys, to the bosom of meadows, or the shade of forests; where we shall proceed to discuss the harmonies of the earth with plants.

Terrestrial Harmonies of Vegetables.

We have treated of several of the minerals composing the globe, such as the long chains of granite mountains, the beds of marbles, calcareous stones, and clays, in the bottom of the basins and on the shores of the ocean; of the iron and copper on the aërial summits of hydraulic mountains, and of the gold and silver in those of lunar and solar mountains. But of all the fossile strata which enter into the composition of the earth, the most useful, rich, and surprising, is that which we are in the daily habit of trampling under foot; I mean the vegetable stratum or soil. It receives the name of *humus* on account perhaps of its being the support of human life, perhaps on account of its receiving our remains. This stratum, forming the surface of the earth, and in our latitudes hardly exceeding a foot in depth, is made up of the remains of fossile and particularly of vegetable bodies, of which it is both the birth-place and the grave. Although a great number of trees derive their nourishment from the interior of the earth by their roots, or from the atmosphere by their leaves, it is only in the midst of the humus or soil that their seeds thrive and send forth the future plant.

Although soil is chiefly formed of the remains of vegetables, we sometimes find in it particles of the hardest rock reduced into sand or gravel. We have already shown that these numerous fragments proceeded from the operation of thaw, or from the action of the ocean; although Newton asserts that the solidity of a stone proceeds only from the attraction of all its parts. Were that the case, the mutual repulsion would have the effect of pulverizing the stone. I cannot help thinking that it is carrying the idea of attraction too far to represent the solidity and hardness of a body as dependent on it. Might we not deduce from this reasoning a strong argument against the attraction of planets, which ought, under such suppositions, to have brought by this time our whole planetary system into a single block, notwithstanding their projecting power. Be this as it may, if, in spite of the central attraction of the earth, all the grains of sand which enter into the composition of a mountain of gravel, such as the Table Mountain at the Cape of Good Hope, are brought near enough to each other, and have their surfaces applied exactly enough to form a solid and lofty mass, how happens it that whenever we meet with sandy mountains, there is no such thing as adhesion even between a couple of grains. If this double wonder arises

from the attraction and repulsion of the grains of sand, the irregularity is as surprising as if a double projection of the characters of the alphabet were to form in the one case a poem like the Iliad, and in the other not a single intelligible syllable. Or, to make another comparison, let us suppose, instead of alphabetical characters, an infinite number of small cubes: which on one side are all joined to the next cubes by their six faces, while, on the other side, all remain separated, although placed one above the other. Yet grains of sand are far from being regular cubes: we shall find, on looking at them with a microscope, that their surfaces are, in proportion to their bulk, more uneven than those of the bleakest rocks. How then is it possible that they could be adjusted and made to adhere, so as to form mountains like the Alps and Apennines?

O vanity and weakness of the human mind! We aim at ascertaining the origin of arts, and our knowledge is so limited that we are unable to discover whether a rock or a grain of sand has been first called into existence. Certain it is that both enter into the structure of the earth in their individual form. Its harmonies could no more exist under a globe consisting of a single block, than if it were reduced into powder. For my part I admire more its solid than its pulverized

parts, although the two are equally astonishing. My wonder is like that of the honest negro, who, on seeing a bottle of sparkling Champagne uncorked, was surprised, not that the wine should come out of the bottle, but that it should have ever got in there. The accumulation of substances in the earth strikes me as more remarkable than their dissolution. Be this as it may, Nature makes both subservient to the harmony of her works, and extracts life from the ruins caused by death. Even fossils which seem perfectly barren, and which are found in layers below the vegetable surface, such as sand, clay, marl, granite, banks of shells, and particles of stones, produce, each in its particular way, a small number of vegetables peculiar to them; but if they are mixed in certain proportions, all these heterogeneous materials compose a fertile soil. So true is it that every thing is in harmony, down to the fragments of inanimate beings. The vegetable covering of the earth may be called a matrix, which absorbs incessantly the solar rays, the vivifying operation of the atmosphere, and fertilizing showers. It is for the purpose of introducing the harmony of the elements that Nature spread abroad on the earth so many insects and animals which perforate it in an endless variety of ways, and that man, following their example, cultivates it with the spade

and plough. Nature, careful of the vegetables sown by herself, has given them deep roots, which are the cause that heat, air, and water, penetrate into the bosom of the rocks.

Let us now see in what manner these roots fasten on the different soils to which Nature has destined them. To begin by solar or fiery mountains: we find that volcanic mountains are extremely fertile at their bases, and extremely barren at the top; yet, as they have birds peculiar to them, there seems little reason to doubt that they have also their plants. Naturalists have remarked a kind of lichen peculiar to a soil of lava. Lichens have, in general, at their roots, a kind of claw with which they fasten on the hardest and smoothest rocks, changing by degrees the surface of the rock into a kind of vegetable earth. They may thus be called the forerunners of vegetation; but as nothing in the landscape of Nature is monotonous, the fiery mouth of a volcano is ornamented with the splendour of the most brilliant minerals. It often happens that its black cone rises amidst verdant forests, and that its crater, yellow with sulphur, sends out a whirlwind of smoke in the midst of an azure sky.

The hyemal mountains, the highest in the globe, are covered with a variety of species of moss. These vegetate in some degree by dint of

the mere emanation of vapours from the soil; for if we expose dried moss to moisture, even some years after it has been gathered, we shall find it revive and resume a green colour. The species alluded to lay hold, by filaments, of the surface of the earth, of rocks, and of trunks of trees, where they grow either in a hanging or in a creeping posture. Nature seems to have clothed with them, as with a fleece, the rocks and trees of high-lying grounds and polar regions, for the same reason that she has clothed the animals of these regions with thick furs. Moss grows in such abundance in the forests of Russia, that I have often, when turning aside from the road, walked in it up to the knees, and driven from it legions of flies. I am inclined to think that it was from this vegetable, or the insect that it rears and shelters in such numbers, that Russia received formerly the name of Muscovy, *propter muscas*, as some ancient philosophers say, or from its being *muscosa*, "covered with moss." There is at least as much foundation for such a supposition as for the notion that Saxony derives its name from *saxa*, rocks.

Another genus equally diversified, though not altogether so numerous as the mosses, is scattered along elevated and mountainous countries—I mean mushrooms. They harmonize with mosses

in the mode of their vegetation, and in the absorption of solar vapours by means of their numerous leaflets; but a striking contrast exists between them in regard to their shape, colour, and particularly their length of life; for while moss is understood to last for ages, a mushroom is the transient vision of a day. The former have a prolonged existence, that they may afford shelter to the seeds of vegetables, and to insects, during winter, while the latter are wanted only for a season to afford nourishment to insects ephemeral like themselves. From among these humble vegetables, trees are seen to rise of lofty stature, and exhibiting marked contrasts with each other. Birch trees, like lofty pyramids, supported by white trunks, wave in the air their pendant scions covered with leaves, which are often stripped off by the severity of winter. These trees are scattered among tapering firs, whose black trunks raise to heaven their evergreen boughs, the symbol of immortality among eastern nations. Their long roots, particularly those of the fir, resemble strong cords, and are used for the same purpose by the Laplander and Samoyede, who make them into bow-strings. These roots wind along the soil of valleys, and twine themselves around the blocks of granite which they are unable to penetrate. They contribute, along with mosses,

to fix the vegetable layers of the soil on the steep sides of hyemal mountains. The eye is no less surprised to behold mountains of snow and rocks of ice rise above a carpet of perpetual verdure, than to see the black cones of volcanic mountains pour forth fire in the midst of forests.

We are justified in reckoning the preceding vegetables among the products of Eolian mountains, because they have not only long and tough roots, but also thin leaves, which give no hold to the winds. Of this description are also pines, firs, junipers, furze, and rushes. Although the summits of these mountains are sometimes bare of earth, Nature covers them with microscopic plants, the roots of which, provided with imperceptible claws, take hold of the hardest surfaces, decorate them with green, black, white, or crimson, and make them look like party-coloured masses of marble. Often does it happen that the liana, like our ivy, takes root at the bottom of these rocks, and spreads a kind of carpeting along their sides, on which they fasten with roots like suckers; while other plants, pushing their roots into the clefts, are suspended with the head downward, and wave like a drapery of verdure at the will of the winds. In Anti-eolian valleys, such as we meet with in Mexico, within ranges of mountains protecting them from every wind,

the cactus, the nopal, the torch-thistle, rise almost without roots, and are supported by the sides of rocks. At Paris, in the Jardin des Plantes, there is a torch-thistle of more than seventy feet in height, stretching out its long arms to right and left; its root does not extend a foot into the ground, and it is enclosed in a kind of glass tower which supports it on every side. This large vegetable seems as if intended to creep along the ground.

In hydraulic mountains, we find trees apparently destined to co-operate with hydro-attractive rocks, in attracting clouds, and dissolving them into showers; such is the tree called *sanctus* in one of the Canary Islands. It is surrounded all night with a fog, which turns during the day into rain, in sufficient quantity to furnish an adequate supply for many of the inhabitants of the island. I spoke of this stately plant, in the "Studies of Nature," when observing that a number of trees possessed the property of attracting aërial vapours and even thunder .We may reckon, I believe, in the hydro-attractive class that tree whose trunk is covered as if by broad planks, which serve as buttresses against the wind in the midst of those rocks where it is found to grow, and where it has scarcely room to extend its roots.

Vegetable products growing in littoral moun-

tains, whether beside rivers or on the sea-shore, have roots calculated to strengthen these mountains in resisting the water: the roots of rushes, reeds, flags, and alders, are interwoven like cords in the banks of our rivers, and defend these banks against the currents. Many species of grass, such as dog's grass and bent, hold fast barren sands by their jointed roots, and protect even the dikes of Holland against the fury of the ocean. But it is particularly in the torrid zone, where tempests seem to increase in violence in proportion to the long continuance of the antecedent calm, that Nature has taken the greatest precautions to fortify tho borders of the sea with vegetable roots. There the barren strand is covered with the boughs of the Ipomæa, called currently in French *fausse-patate*, a kind of creeping liana which extends like a net, and with strings of such length and strength as to be used by the negroes in catching fish. Cocoa-trees take root on the sea-side by a multitude of filaments, which render the sand solid as a rock; and the tree stands as firmly as a column on its pedestal. But Nature is not content with raising trees, like pillars, on the sand of the sea-side; she decks it likewise with rich displays of verdure. The Banian-tree throws forth, from the extremity of its branches, roots which penetrate into the sand, and form

round its trunk a number of arches and vaults, the lower parts of which soon become new trunks. Thus does a single tree produce, in the midst of these burning sands, a forest, the roots of which are inaccessible to the waves, while its foliage is impenetrable to the sun and rain.

Littoral mountains, whether beside rivers or on the sea-shore, support under water the vegetable products, the roots of which tend to strengthen them against the effects of tempests. It is on the banks of rivers, and at the bottom of their channels, that we find the roots of rushes, reeds, nymphææ, iris fœtidissima and sagittaria: they are interwoven to such a degree as to require being cut annually in many situations, as otherwise they would obstruct the course of the water. It is these roots which, by stopping the mud and sands, raise in the course of time the banks of rivers above the soil of the neighbouring plains; we often find there willows and alders, with roots almost as tough as cords. If one of these trees happens to be overset by an inundation, the fallen boughs frequently take root and reproduce a number of trees instead of one. Thus does Nature extract a remedy from the evil itself, and, by harmonizing the vegetable with the aquatic kingdom, give a bed to rivers and openings to forests. It is thus that the Mississippi and other American

rivers run; their banks being covered with canes and a number of other vegetables, and forming lateral dikes on the right and left, between which the waters run on a level with the adjacent plain. Littoral mountains near the sea are likewise strengthened by submarine vegetables. Sea-plants may be, in general, considered little else than roots, which, immersed in the depth of water, extract nourishment from it through all their pores. At their lower extremity they are fastened by a kind of gluten, not dissolvable by water, and adhere by means of it to rocks: they are hard as leather; long and supple as cords; and some of them, like the fucus giganteus already mentioned, are of nearly two thousand feet in length. They are in general terminated by a bunch of leaves which remains near the surface of the water, no doubt for the purpose of receiving the immediate influence of the sun and air. Those which grow on the borders of the sea in our climate, and are uncovered twice a day by the reflux of the tide, are more leafy than those which grow at a great depth of water. I have often seen with pleasure, on the coasts of Normandy, masses of white marble mixed with beds of black pebbles, detached originally from the cliffs, and covered, by the action of the salt water, with fuci and algæ. I used to observe, hanging

from the sides of the rocks, brown, green, purple and crimson tufts and garlands above and below the azure waves; while they rose and sunk with the water, as if they had been merely billows of a different colour. There are in the depths of the ocean a multitude of plants unknown to our botanists, and which form a thousand harmonies foreign to our systems. Not only do they supply shelter and nourishment to an endless variety of testacea, fishes, sea-birds, and amphibious animals; but they give strength to the shores of the ocean, as is sufficiently shown by the encroachments on the banks of rivers in situations where vegetable products have been removed to serve either for manure to the husbandman, or materials to the manufacturer. But it is on the terrestrial part of our globe, on the sides of our hills, in the bottom of our valleys, and in our plains, that the roots of plants extend in a variety almost as great as that of the vegetables above ground. Some are formed like long hair, or like cords; others with joints, which harmonize with sand, rocks, flint, or clay; each preserving its shape in conformity to the soil destined by nature for its support. I have seen, in lime-stone quarries, vine-roots push their long filaments to the depth of fifteen feet into the rock. The dog's grass interweaves its filaments in the sand, and fixes it to the spot; while those

of the anemóne nemorosa extend, like a net, along the surface of the earth, in woods, where they knit together the various parts of the soil. The elm extends its roots, like its shade, along the slope of hills; and the oak buries its long pivot nearly as far in the ground as it raises its head into the region of tempests.

Few objects strike us with more pleasure than a fine forest. The trunks of such trees as beech and fir surpass in height and in beauty the most magnificent columns, while their arches of verdure excel in boldness and in beauty those of the largest monuments. During the day-time, I behold the sun's rays penetrating this thick foliage, and describing on the earth light and shade amid a thousand tints of verdure: in the night I observe the stars rising in different situations along the tops of the trees, as if they were borne in their boughs. A forest may thus be compared to an august temple which has its columns, its porticoes, its sanctuary, and its lamps; but the foundations of its architecture are still more deserving of admiration than its height or its ornaments. This immense edifice is moveable; the wind blows; its leaves are agitated and appear in two distinct colours; the trunks shake along with their boughs, and spread a sacred murmur around. What power keeps

erect these moving colossal pillars? It is their roots. It is they which, in the progress of ages, have raised on a barren tract a vegetable stratum, which by the power of the sun has changed water into sap, and sap into leaves and wood. It is they which are the cordage, the levers, and the absorbent pumps for these great pieces of Nature's workmanship; it is by means of them that it supports the impetuosity of blasts capable of overwhelming the most stately towers. The sight of a forest produces in me the most agreeable meditations, and makes me say, as when we happen to be spectators of some of our most magnificent theatrical exhibitions: "The maker of the scenery, the painter, and the poet, are under the theatre and behind the curtain; it is they who have prepared all that I see, and who make it move along with the actors. In like manner, the fundamental part of the trees of a forest is under ground, and that which is hid from my eyes is still more deserving of admiration than that which I see."

Although all mountains, and even rocks, are capable, as we have seen, of supporting vegetables, there are still parts of the earth more particularly destined for them by the shelter they afford; I mean more especially valleys, for it is there that the rain collects soil. In our climates

the most favourable exposure is to the east or south. We are accustomed to distinguish plants into southern and northern, but we might distinguish them farther, into eastern and western. We shall treat of such classifications when speaking of the vegetable harmonies of the earth; at present it is sufficient to have given a sketch of the terrestrial harmonies of vegetables.

Terrestrial Harmonies of Animals.

However numerous and interesting may be the harmonies of vegetables with the earth, they cannot be compared to those which animals have either with the earth or with the other elements. A tree does not bear down by its weight the soil in which it grows; it supports itself there by its long pivots, by the different stages of its roots, and, in some measure, by means of its foliage. With a quadruped of equal weight the case would be very different; for the whole pressing on the surface of the earth, and the soles of its feet being narrow, the result would probably be his sinking into the ground. An elephant, the heaviest of quadrupeds, weighs much less than a cedar or a whale. There is likewise a very remarkable difference between the centre of gravity of the tree and that of the quadrupeds; in the former it is low, because it is destined to be at rest; while in the latter it is high that it may admit of a forward motion, which takes place only when he advances his head and body. On considering the trees of our parks and orchards, whose trunks are bare, and whose heads are burdened with a quantity of leaves and branches, one is led to think their upper part the heavier of

the two, without considering that this shape arises from the care taken to remove the branches from their trunk from the earliest part of the tree's growth. Were they left in their natural state they would have branches from their root upwards, and would acquire a good deal of the pyramidical shape. I have seen this occur in the case of neglected elms, which had pushed boughs from beneath to such an extent that it was impossible to pass between the different trees, or even along their avenues. Thus has Nature given to the trees of the forest a kind of ladder for climbing their sides. I know hardly any other tree than the palm where the branches are confined to the head. Yet although the head of palm-trees is sufficiently broad, its weight is small when compared with that of the lower part of their trunk, and particularly of their roots, which consist of a multitude of filaments forming a solid mass, along with the sand, from which they extract their nourishment. In considering trees in a general way as great levers covered from top to bottom with greater or smaller stages of verdure, and shaken by winds which make them describe segments of a circle, I cannot withhold myself from admiring the prodigious strength of their roots, which have often a hold of nothing but sand or marshy ground on which we should

not venture to erect the slightest edifice. But I am still more surprised on seeing heavy animals possessed of a moving power which pushes them at their pleasure backward or forward, to right or left, upwards or downwards, agreeably to the different nature of the spots which they traverse.

Although all animals are subjected to the centripetal power of the earth, they have, as is universally known, a power of progressive motion peculiar to themselves, by means of which they surmount this general power of attraction, either by flying in the air, swimming in the water, or moving along the ground. We have seen that great diversity exists in their manner of flying and swimming, and we are now to make a few observations on their mode of walking, which is found to present still greater varieties. In fact, animals moving along the surface of the earth, being supported by no fluid, have a much greater variety of organs, and of means of moving forward, than birds or fishes. Some of them slide, creep, walk, leap, roll, dance, &c. by means of membranes, rings, springs, and feet, the shape of which is adapted to the soil which they inhabit, and to their different wants. Nature has made the surface of the earth sufficiently compact to withstand the pressure of the heaviest animals, and at the same time sufficiently light

to enable insects and vegetables to pierce it. It is thus suited, by its density and its rarity, to the moss or the ant, while, at the same time, it is capable of supporting the weight of the cedar and the elephant. This observation was made, I believe, by Fenelon, and I embrace the present opportunity of acknowledging its importance.

But this is not all: Nature has put the heaviest animals in harmony with the earth, in such a manner that they should not sink into it by their accelerated movements which have the effect of doubling and trebling their weight. The feet of quadrupeds will generally be found to increase in breadth in proportion to the degree of pressure on them. The bones of their legs are not in a straight or perpendicular line, but somewhat arched on the outside, and even behind, for the purpose of better supporting the superincumbent weight. Nature has divided their legs into different joints provided with sinews at the foot, the knee, and the thigh, to prevent the animal from falling with all its weight, which would undoubtedly take place if the legs were of a single piece. She has moreover strengthened the foot with very thick leather, and with a horny substance which is both hard and elastic. The consequence of all these precautions is that a heavy

quadruped often moves as lightly as those of much inferior weight.

The elephant has four legs, which from their size may be called jointed pillars, and are terminated by feet somewhat concave in the lower part, with five flat hoofs which enable him to climb the sides of mountains. His step is very sure. The philosophic Chardin, who had seen numbers of them in Persia and in India, says that in walking they make hardly more noise than a mouse; that they get on very quick, and that if they come behind they overtake you before you perceive them. It appears therefore that he does not gallop; for, if he did, his weight, increased by the fall of the foremost part of his body, would plunge him into the ground. What would be the consequence were he to spring like a goat? He would beat down the ground when he fell, and receive much injury himself. Thus has Nature proportioned the weight of animals to their mode of walking, and to the thickness of the earth, in the same way as she has adapted that of birds to the resistance of the atmosphere, and that of the whales to the joint equilibrium of the air which makes them float, and of the water which supports them. Had we an animal of the size of a whale, walking or even creeping along

the ground, it would make a succession of hollows by its weight, and would carry destruction among the vegetable products.

Nature, like a kind mother, not only gives support to animals, but affords them an asylum and place of rest in every direction. It is partly on this account that rocks are filled with clefts and creviçes, and that sands are moveable, from the caverns in the rocks of Abyssinia which afford a den to the lion, to the downs of Europe where the rabbit digs his hole. On the other hand, all animals have received organs, muscles, and skins covered with hair, and other compensations in conformity with the different degrees of density in the ground, as well to enable them to traverse it in all directions, as to find hiding and resting places in it.

To obtain an idea of their harmonies with the earth, we shall consider animals under the double relation of motion and repose. By way of giving precision to our observations, we shall class them in the order in which we treated of the harmonies of the earth properly so called, beginning with those animals which inhabit solar and hyemal mountains.

Animals of the torrid zone, and of the hotter part of the temperate zone, have in general very long necks and legs. It is there that we find the

slender gazel, the camel, the dromedary, and the camelopard, (some of which are eighteen feet high;) the ostrich, called by the Arabs the bird-camel; the cassowary, the egret, the ibis, and several quadrupeds accustomed to leap and skip, such as the ape, the palmetto-rat, the *mus jaculus*, which leaps over the sands of Egypt; and, finally, a number of reptiles which are in the habit of springing like a dart. I am inclined to think that most of these birds and quadrupeds have an additional length in the organs which favour their forward movements, in order that their organs of breathing may be raised above the heated reverberation of the soil. It is remarkable that lions, camels, and apes, have wider nostrils than the animals of cold countries or icy mountains. Nay, a similar difference exists in the shape of the human inhabitants; the negro having longer legs and thighs, with a broader nose, than the Samoiede or Laplander, who again are shorter in their proportion than the inhabitants of temperate climates.

On the other hand, animals living in the frozen zone, or in hyemal mountains, have short legs and necks, for the purpose apparently of having them nearer the centre of warmth in their body. At least it is evidently with a view to warmth that the extremities of their feet are so often co-

vered with hair or feathers. Their organs of breathing are likewise narrower, that the cold air which they respire may not get into their lungs in too great a quantity at a time. It is, no doubt, on this account that the foxes and white bears of the North have a long and pointed muzzle, in contradistinction to the tigers and lions of the South, in which it is short with wide nostrils. The elk of the north of America has protuberances which appear to protect the opening of these organs in him; and the Tartars of northern countries are obliged to open, with some degree of violence, the nostrils of their horses, to facilitate their breathing in the rapid movements which they make them execute. If the feet of the animals of cold countries are all similar in being nearer to their body, they differ from each other in point of shape, agreeably to the nature of the soil which they inhabit. The feet of the rein-deer are cloven, and separate in walking to prevent sinking into the snow where it seeks its food. Other animals, and particularly sea-birds, such as the Arctic diver of Norway, have a feathered covering all the way to the point of their toes; the white bear is armed with claws to catch hold of floating ice, while the heavy amphibious animal called the sea-lion, no bad emblem of a cask of oil, has two strong curved teeth with which he drags

himself along the strands of Greenland and Spitzbergen.

Among the inhabitants of the Eolian mountains we ought, no doubt, to reckon those which fly about, whether birds or insects, and which are to be found in all situations. We have given an idea of the manner of flying in these animals, in treating of the aërial harmonies; we have spoken likewise of the mode of flying of some quadrupeds, as the bat and flying squirrel; we shall now say a few words on the manner of walking of animals which have more or less frequently recourse to the wing. Birds have two feet, generally divided into four toes, three of which are before and one behind, for the purpose of laying hold of the branches of trees. They take so firm a grasp of them as to remain asleep on them during the most violent storms, and sometimes to retain their hold after death. They have a variety of methods of walking along the ground: some, like sparrows and magpies, are in the habit of skipping; others of dancing, like the Numidian crane; others of poising themselves from right to left, like the duck and parrot; while another class walks with all imaginable gravity, like the cock and peacock. Most insects have their feet armed with little claws, by means of which they take hold of smooth and polished

bodies. Claws and crooked nails are given to birds, not because they are carnivorous, but because they are in the habit of climbing trees and steep heights. A cat has hooked claws, because it is destined to climb, not only trees, but the roofs of houses to seek its prey; while the dog, carnivorous like the cat, but destined to find its food on the ground, has no curvature in its claws. A similar remark will be found to apply to the claws of the tiger, the lion, the white bear, accustomed as they respectively are to climb rocks or ice, in contradistinction to the fox, the wolf, the hyena, which are equally carnivorous, but destined to inhabit plains. As to animals that pasture in steep mountains, such as the goat, the doe, the chamois, the pacos of the Cordilleras, they have cleft feet terminated by two claws, with which they support their weight on the hardest rocks, where they thus find no less than eight points of contact. But it is particularly in insects that we have an opportunity of observing the care of Nature in preventing light bodies from becoming the sport of the wind. They have not only in general sharp claws to their feet to enable them to take hold of substances as smooth as ice, but they have a kind of tubercles, between which they draw in their claws, like cats, that they may not unnecessarily wear them in walking on plain

ground. This curious appendage may be seen in flies in our rooms, when going up and down the perpendicular glass of our windows. Some caterpillars, like the one which lives on the trembling leaf of the poplar, have, in addition to the ordinary claws attached to their rings, a kind of circular slipper formed of hooks, which holds them fast to the leaves of those trees, subject as they are to perpetual motion by the winds.

The animals which inhabit only the tops of hydraulic mountains, or the bases of littoral mountains, have different methods of moving forward. The former, in warm countries, are covered with tufted hair sufficient to protect them from damp: this is the case of apes, who have five toes to each of their fore and hind feet, with pliant tails by means of which they lay hold of the elastic branches of bushes, and leap over precipices. I have seen them, in the Isle of France, run along the slightest cornice of a lofty rock, on the sides of which they looked as if sculptured in relief. Squirrels living in snowy mountains have still thicker furs; some species in the north of America have bunchy tails with which they cover their heads, and which serve them occasionally as a screen against cold. Another species is found with a membraneous skin adhering to their feet, by means of which the animal springs from rock

to rock. Such is the case with the squirrels of the marshy mountains of Labrador. Birds in high and rainy situations, such as most sea-birds and birds of prey, and even pigeons, have the upper part of their plumage very close, so that the rain, and sometimes even the sportsman's ball, glide from off its surface. A great number of insects are evidently shaped with a view to enable them to lay hold of moist walls. The spiders, and a number of other weak insects, have the instinct of foreseeing rain, which is so contrary to their labours; but a snail, sheltered by a scaly covering takes a delight in moving along damp walls by means of his muscular and glutinous membrane.

A similar diversity exists in the manner of moving along the lower part of littoral mountains. The sea-snail makes his way here, like his brother of the land, by means of a muscular membrane, without however having any gluten to assist him in gliding forward, because the soil which he traverses is always wet from being under water. The univalves are the only description of shell-covered animals which live on dry land, because their shell bears wholly upon the organ by means of which they move forward. The shell is thin in land-snails, while it is thick in sea-snails, exposed as they are on the shore to the rolling of stones and pebbles, while

at the same time it is so light as to be borne up by the salt water. The consequence is that sea-shells are in the same relation in point of density to those that are found on rivers or on the ground, as sea water, impregnated with salt, is in point of weight in regard to river water; Nature having established throughout a perfect harmony between the elements and the animals of similar species which inhabit them. A large buccinum is no more burdened by his weight at the bottom of the sea, than a land-snail with his thin coating on the branch on which he creeps. The heavy nautilus, as well as the papyracea, rise on the surface of the sea by making a vacuum in their numerous little cells. They then raise a kind of sail, and go where Nature guides them by aid of winds and currents. There are no bivalve shell-fish on the land, because their two shells with their hinges must be raised laterally by water, to receive support from the kind of tongue which serves them as a leg. It is by moving forward in this manner that the cockle, the pinna marina, the dail, and the muscle, walk or rather drag themselves along. The crustacea, such as the urchin with its long spines, roll upon the sands; others, armed by eight toes divided by three joints, like the lobster, the crawfish, and the Palinurus Homarus, move backward among the rocks, or

sidewise like the crabs. They have likewise two formidable claws like pincers, with which they destroy the petty shell-fish which serve them as prey. It is in places such as these that we find the conger, which glides along like a snake. It is on the sea-shore that we find a number of amphibious or aquatic insects; it is there that the pagurus bernhardus lives on the dry strand, Nature not having covered his hinder parts, that he might lodge them in an abandoned univalve. We thus see that nothing is lost, the covering of a snail serving for a pagurus, and the industry of a dead animal to meet the wants of one that is in life. Creatures living at the side of water appear to combine all the organs, and all the instincts, of those which live in the three elements of whose borders they are the occupants. Who could enumerate the various modes of motion adopted by sea-birds and amphibious animals? The former have a reservoir of oil near the rump, which they use to trim their feathers, and preserve them from the bad effects of too much moisture. Amphibious animals are very numerous, and form striking contrasts with each other, from the sea-calf which exposes his young to the sun on sand-banks, to which he drags himself by his short and membraneous feet, to the long-necked, short-legged flamingo, which stands erect with his feet

in water, and with his rump fixed on the top of a little mound of mud in which he hatches his eggs. The one is marble-coloured, and looks as *sombre* as a piece of rock; while the other, of a bright fire colour, appears like a flame arising out of the bosom of the water.

On examining the motions of animals along the ground, we find them still more numerous than the foregoing. Their feet are not terminated by bones, but by a horny substance, which unites the apparently opposite qualities of hardness and elasticity. This substance is thus better calculated to go through its functions without injury, than bones which would naturally be worn away by rubbing. It sometimes covers the whole body of an amphibious animal, such as the tortoise, and defends it against the fall of stones, as well as against the rubbing of sand. In amphibious animals this horny substance seems formed by an amalgamation of scales, and in quadrupeds, of hair. The trace of this hair is very clearly apparent in the horn of the rhinoceros' nose, as I have myself seen in the case of that animal at the Paris menagerie, who had worn down his nose to the stump by rubbing it on the paling of his enclosure. The hair on it was large and straight, as may be seen by looking at the parts preserved in the Museum of Natural

History; but it is thin and interwoven in the horn of the foot of the horse, exposed as he is to a greater share of fatigue. The horn of animals supported by interior bones, as those of the head of cattle and of goats, seems, like the hoofs of their feet, to consist of scales. In the feet of animals the hoof grows over and over again, although incessantly worn by rubbing, and pressed down by their weight. In the horse this horny substance is of a single piece; circular and somewhat hollow beneath, that it may sink less into the ground; and sloping inwardly from the fore-part, that it may receive a support in the ascent of mountains. It is common throughout all Europe to cover the inside of this with a semi-circular iron, fastened with nails, under the impression that an iron shoe prevents the horse's hoof from being worn, and gives greater security to his step. We need not wonder that, in countries where men cover their own feet, something of the same kind should be done in regard to animals; but I am by no means sure that the walk of either is benefited by it. It is not the practice to shoe horses at the Isle of Bourbon, where I have seen them run, like goats, among the rocks with which that island is covered, and the consequence is that their hoofs acquire an extraordinary degree of hardness. The

negroes, who go barefoot, experience a great deal of difficulty when they wish to bridle and saddle them, although negroes run along these mountains much better than any European.

Quadrupeds, who, like cattle, are destined to traverse the soft soil of meadows, and the marshy banks of rivers, have cloven feet. They are shod, and with great propriety, with iron plates, when taken away from this their natural footing, and made to move along the pavement of our towns and roads. Similar precautions are taken even with cows, when brought from a distance; but they are superfluous in all cases where the animals remain in the situations intended for them by Nature. Cloven feet do not sink easily into the ground; and in addition to these, cattle have, above and behind, two addititional points of support on each leg, so that they have altogether no fewer than sixteen different defences against sinking.

The case is the same with the feet of the hog, an animal often found in marshy ground, and who in fact takes a pleasure in wallowing in it. As he lives principally on the roots which he seeks there, he has around his long muzzle a snout, gifted with an exquisite sense of smell, with which he digs up the ground. As his hind legs are higher than those before, and

his head is moved greatly forward, the whole weight of his body comes in aid of his digging labours. His hind legs, like those of all other quadrupeds, form two kinds of arches, curved backwards, not only for the purpose of supporting him when placed against the ground, but to aid him in springing forward. I conclude therefore, in contradiction to the current notion, that the body of the hog bears no resemblance whatever to that of a man, whose legs, on the other hand, form two curves forward, towards the knees, in order that, as he is destined to walk erect, they may give a backward inclination to the greatest portion of his weight.

To return to the shape of the hog, destined to turn up the ground, we may consider him, from his incessant activity and from the nature of his motion, as a kind of living plough. Our plough, though celebrated in mythology as a sublime invention of Triptolemus, is nothing but a very imperfect imitation of the shape of an animal which we look on as formed with very little pains at the hands of Nature. The weight of our plough lessens its action by pressing on the hinder part; while that of the hog is increased by his forward pressure. Our ploughshare opens a furrow only at one side, while the round snout of a hog opens two at a time, and labours in every direction.

Once for all, we ought to acknowledge that the machinery of Nature is much superior to ours, and may be applied to a variety of uses. Sheep and goats, which seek their nourishment on the steep sides of hills, have likewise cloven feet; they are accustomed to take hold by means of their hoofs, and the goats often make use of those of their hind feet, to stand upright, and to browse on the upper part of shrubs.

Small quadrupeds which, like rats, live on fragments of almost any substance, and shape their way in every direction, have claws with which they climb during night along the rough side of a wall, to the height of almost thirty or forty feet. They have, moreover, four cutting teeth, which are prominent, and sharp as a chisel, with which they find means to eat through beams of more than a foot in thickness, and of the greatest hardness. Of this I have been a personal witness in the Isle of France, where I lived in the second story of a tower, where these animals found means to penetrate during the night. They are so numerous in that island, and commit such ravages, that the only way to save victuals from their devouring mouths is to put them in warehouses supported by four pillars, surrounded at the top part with tin plates. Receptacles of that description might be useful

in Europe for containing grain; they would not only form a defence against ravages of that description, but, what is more, against moisture, which in our climates is much more to be dreaded.

Animals inhabiting spots where vegetation goes on, as well as insects residing in vegetables, have very different methods of moving forwards: the chief ingenuity is displayed in the case of the smaller animals. I have already mentioned the slow-paced snail, which creeps along the branches of trees by means of a muscular membrane, and of a glue which the strongest winds cannot shake. I have spoken likewise of the hooked slipper of the caterpillar, whose abode is on the moving leaves of the poplars. A number of caterpillars have not only rings which serve them as feet, but threads by means of which they hang in air, and long hair around them which preserves their tender bodies in case of a fall. Insects living under the tufted grass of meadows glide to the bottom of their roots, and are enabled to run rapidly thither by means of the shape of their feet, and from their bodies being smooth, or inclosed in cases, as is the case with beetles and republican ants. Others, which derive their nourishment from stalks of grass, and which, like grasshoppers, cannot run along them, have two long legs with springs, which enable them

to make leaps in a parabolic direction. Some insects of this description have likewise wings, by means of which they traverse immense districts in innumerable bodies. They look like horses equipped for combat, and carry what seems a sabre or sword at the extremity of their body. They may be called Nature's reapers; for they spread themselves throughout meadows abandoned by men and quadrupeds. The millepede, unprovided with means of defence, seeks for support under stones and in the shade, but when pursued by his enemies, he by no means trusts for his escape to the number of his feeble feet; like another Proteus, he metamorphoses himself forthwith, and instead of a creeping insect becomes a rolling ball.

What shall we say of the walk, or mode of movement, of those animals who live by preying upon others? The spider, driven from its ambush and unable to find a road upon the ground, makes one for itself through the air; it weaves a thread, and, when the wind has fastened one of its extremities to a fixed point, it runs along it like a rope-dancer. This aërial bridge serves sometimes for the accommodation of other insects, and particularly for the feeble cochineal, which it enables to pass from the thick leaf of the cactus, where it was born, to the spot where it is

about to fix its brittle trunk under the shelter of the thorn. Other insects introduce themselves under the hair of animals, or skip, like fleas, to a distance of a hundred times their length. Who would undertake to describe the different organs of motion in land-animals? They are as numerous as the obstacles they have to encounter. The movement of terrestrial animals is more varied than the swimming of fishes or the flight of birds; and their feet are much more numerous and diversified than the fins and wings of the two other tribes. It very seldom happens that a quadruped has either fins or wings; but most amphibious animals, all birds, all insects accustomed to take to their wings, and even almost all aquatic insects, are provided with feet.

In fact it is to the earth that the majority of animals attach their existence: winged insects make their nests there, and those which live in water come to spawn in the vicinity of land. All who make it the scene of their movement make it the scene of their repose. Those which inhabit the frozen zones and hyemal mountains are clothed with tufted coverings, and with skins provided with feathers or down, on which they may securely rest in the midst of ice and snow. The tenants of the frozen ocean in the north and south, such as whales, have, under an elastic

coating, layers of fat of great thickness, which preserve their natural heat, and protect them from the shock of floating ice. Others, like the sea-lion, which move slowly along the shore, are covered with a loose skin and soft fat; like a flask of oil, they glide without trouble and without danger along rugged rocks, and sink there into profound sleep amid the noise of the raging waves. Others, inhabiting generally the bottom of waters, are found to seek refuge occasionally in the caverns of rocks. It is there that a number of fish, in a stiffened state, come to look out for an asylum against winter and against old age, that long winter of life. It is in such spots as these that the feebler kinds of fish are placed by Nature beyond the rage of the tempest.

Shell-fish carry with them a roofy covering, which protects them against the fall of stones and rocks. The inside is not smoothed by down; but a splendid burnish of the richest colours of the East affords a soft resting-place to their tender flesh, and covers the inside, and sometimes the outside, of their habitations. The muscle, shaped like a boat, casts anchor on the strand with a hold as secure as a ship's cable. The sea-snail lays hold of rocks by its membrane; the lepas by forming a vacuum in them with its funnel; the oyster, the vermicularia, the coral, and

the madrepore, are fastened to rocks by means of a cement calculated to withstand the dashing of the water; while others, like the dail, penetrate the side of calcareous rocks by means of their shells, which are rough like rasps. Some appear to have the power of foreseeing the storms, and of taking shelter from their rage. This they accomplish by immersing themselves entirely in the sand, like the smooth-coated shell-fish. The sea-worms without any covering, and a number of small fish, as well as the huge tridacna gigas, remain immoveable on the reefs, under shelter of their thick vaults; but the crustacea, such as the lobster and crab, take shelter amongst the rolling stones, and as they would be exposed there to have their claws broken, Nature has given them the power of re-producing them in the same way as she has given trees the power of sending forth branches to repair the damage of the winds.

But why should we seek to penetrate to the bottom of the sea for the sake of observing the means of repose provided by Nature to living creatures? We shall be at no loss to find sufficient examples on land. We have already remarked that the hind legs of quadrupeds form a kind of buttress, and we are now to observe that their fore-legs are perpendicular; the former

being instruments for moving forward, the latter for supporting the superincumbent weight. In fact it is on the latter that they stop and rest even their heads when asleep. Nature has moreover given them a belly without bones, on which they may recline their whole body, particularly after extreme fatigue. At the same time, by way of enabling them to vary their attitudes in standing as well as in walking, Nature has covered the thighs and shoulders of the heavier animals, such as horses and oxen, with fleshy and prominent muscles, that they may be enabled to take rest by turns on either side. She has destined them likewise to live in the midst of meadows where the grass affords them an ample couch. Others find retreats prepared for them in the moss which covers the hollows of trees and rocks; such are squirrels, marmots, and porcupines. Other species again bury themselves in the bosom of the earth; such as rats, rabbits, moles, bees, wasps, may-bugs, crickets, ants, ground-worms, and a crowd of other insects. These deposit in the earth the cradles of their young, and contrive to introduce into them the sun and air, the two primary elements of life and vegetation. I have seen a meadow, adjacent to my residence on the banks of the river of Essonne, full of an infinity of holes made by a

species of beetle, without having a single foot free from the marks of these insects. Each beetle stood in the sun at the entrance to his little hole, and when I passed that way by a path leading across the meadow, at every step that I took, thousands of these insects drew back at the same moment to right and left. It was in vain that I attempted to catch a single one; but towards the end of autumn there arrived a number of crows which took up their station in that quarter for the winter. These formidable enemies waited patiently on the spot, and when a beetle appeared at the mouth of his hole, they swallowed him immediately, so that they cleared the meadow entirely, and were instrumental in restoring the vegetation; for the grass had already suffered by the labours of these insects. It is, no doubt, with a view to enable them to pierce the earth, that most beetles have their wings provided with a polished sheath, which is frequently oily to prevent injury from damp.

As soon as the sun, the grand spring of the movements of animals, sinks below the horizon, each withdraws to his place of rest. The gilded insect lies close to the bosom of a flower; the butterfly folds back its wings and falls asleep on the petals; the bird perches on a branch under

the shelter of leaves; but as his head and long neck might incline him too far forwards, and would moreover be exposed to the night cold, he puts it under one of his wings, and brings it near the warmth of his breast. The quadruped sinks in sleep at the bottom of a tree, folding his legs under his body. Could we then have an opportunity of contemplating the landscape, we should see all its inhabitants in new attitudes and motionless. It is thus that end the labours of animals accustomed to go abroad during the day: while those that seek their prey by night go forth generally with the rising moon; as if it were ordered that there may always be some eyes that profit by light, however slender, and that are attentive to the spectacle exhibited by the universe.

When winter, which may be called the night of the year, draws near; when the sun passes into another hemisphere, and the north wind shakes the forests and strips them of their verdure; most insects seek a retreat in the heart of fruits, under the bark of trees, and in the solid part of their trunks; others, changed into nymphææ and become the sport of the winds, hang on threads, and seem to find their rest in a kind of perpetual agitation. A number of birds take

shelter in the hollows of trees, and under the evergreen foliage of the fir and ivy; the marmot falls asleep in the hollow of the rocks.

But when the lapse of a certain number of revolutions of the sun and moon announces the approach of a night which with them must last for ever, each seeks to end his days near his accustomed habitation. The domestic fly, fond to the last of light, expires near the windows; and the butterfly, with extended wings, sinks into rest at the foot of its favourite flower. The faithful dog quits his couch, and yields his last sighs near the spot which he has watched; perhaps at the foot of a master whom he has guarded for years. The elephant retires to die on the borders of a stream in the midst of a shaded valley. This remarkable circumstance is attested by the African hunters, who are quoted by Bosman, the traveller; and it is perhaps to the effect of this instinct that we are to attribute the great number of elephant-skeletons found in a collected state on the borders of rivers in Siberia. Man, faithful, like every animal, to his natural habits, feels also a strong desire to breathe his last in his native land. When the moment of death draws near, he casts his view toward heaven, and looks around for a friendly hand to close his eyes and erect

his tomb. This double instinct, towards heaven and towards earth, is found to exist among the most uncivilized part of the human species, and cannot be traced, as far as we have yet been able to discover, in any animal.

Terrestrial Harmonies of Man.

COME and inspire my mind, Celestial Harmony of rest and motion. Thou art not in man that blind attraction which fixes him, like an inanimate body, to the surface of the ground, nor art thou in him that law which makes a planet describe an ellipsis round the sun by a combination of double motion. Thou art an emanation of that universal soul of the world which organizes every object for a specific purpose, and to which motion and rest of every kind is subordinate.

It is to thee that we are indebted for the first lineaments of the human frame. Our bones are arranged with exquisite skill; joined by cartilaginous, and provided with fibrous muscles. Our limbs receive their impulse from muscles, and the circulation of the purple streamlets in our veins is almost as wondrous as the course of those worlds which derive their light and heat from the orb of day.

It is by the invisible impulse of the harmony of rest and motion that the eyes of all animals are opened and closed. It is this which calls us forth in the morning when the sun appears on the horizon, whether we employ ourselves in

traversing mountains and valleys, or in gathering those fruits which we have reserved from the bounty of Nature. Different employments belong to difference of age and sex. Young females, formed on a tender model, give a preference to tranquil employment. Seated under the shade of a tree, they twirl the distaff with their fingers, or make the shuttle glide through the web. But when the moon begins to spread her silver light on the meadow, they delight in joining their fair companions in the dance. Our sex, animated by the sight, forget the labours of the day, and join in the sportive round.

The harmony of rest and motion operates on all our actions without our being able to analyze the principle or its manner of exercising its influence. A philosopher may indulge sensations of surprise on considering that movements so skillfully combined as those of the human frame should be under the direction of minds so little informed as those of the major part of mankind. He may consider us as having a double kind of soul, the corporeal and the mental; the former wholly under the direction of the latter. He may farther speculate on the ignorance of our minds in regard to the complicated machinery we thus put in motion: like those eastern monarchs

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who, without a knowledge of their subjects, issue an order affecting a whole empire, by a mere sign transmitted by a mute to a vizier.

Uninstructed however as the human mind frequently is, a desire of knowledge is very generally found to exist in it. Not satisfied with its actual state of information, it has a strong wish to collect the history of the past, and to anticipate the events of the future. From this world, where it fills a humble station, it turns its efforts towards heaven, and dwells with transport on innate feelings of infinity, eternity, glory, and immortality. It may even be said to feel the same kind of consciousness from impressions of this description, as from those which are merely corporeal. Our minds may be considered an emanation from that Divine Mind which governs the world, in the same way as our body is made up of elementary substances, and affected in its operation by those influences which regulate the works of Nature at large.

Our soul, said Marcus Aurelius, is a "god in exile." It is in vain that, stimulated by its celestial instinct, and aided by the acquired knowledge of past and present ages, it seeks to penetrate and comprehend the surrounding works of Nature;—its progress is confined in a great measure to external observation. Enclosed in a body, it is like a navigator in a feeble bark, in the midst of

a stormy ocean, who seeks to land on some of the islands of which he perceives the shores. He may succeed in acquiring an idea of the outline, and in giving names to particular objects; but the interior of the country, and the manners of its inhabitants, remain hid from his observation. Our arts and sciences, in spite of their pompous names, are but remote and illusory images of the works of Nature. Painting, for example, gives us but a mere sketch of the earth and sky, representing very imperfectly light, air, water, earth, and vegetables. Sculpture is liable to the same objection, and exhibits to us, in her most finished pieces, figures which can neither move, speak, nor feel. Poetry is proverbially founded on fiction, and affects to give a divine character to things which are merely the works of a Divinity. Even the sciences, which we call *exact*, are limited in their progress, and founded frequently on uncertain notions. Mathematics admit points without surface, and lines formed of points possessing length without breadth, which is a double contradiction. We are still unacquainted with the precise relation of the circumference of a circle to the radius which generates it. Our theorems are merely sketches of some property of an inanimate sphere, but those of the living sphere of the sun are almost wholly unknown to us. Our astronomical

knowledge, in like manner, does not go beyond an acquaintance with the apparent motions of planets.

Yet, to arrive at a knowledge of the different relations of man, let us not hesitate to follow the route which those orbs that are the primary movers of our elements seem to point out. If we go astray, it will be in the footsteps of universal reason, not on those of our own, which is so feeble and so versatile. We shall now endeavour to exhibit the relations between man and the terrestrial harmonies, in the way we have already done in regard to the aquatic, the aërial, and the solar. We have seen that he is in correspondence with the air by means of his lungs, and with water by means of various organs; and we shall now proceed to see that his whole body is in harmony with the earth and her different productions.

A kind of analogy may be made out between the surface of the earth, diversified as it is by mountains, valleys, or rocks; and the human body, covered by muscles which are separated by intervening cellular membranes. Our veins may be compared to streams and rivers, and our blood, circulating in our veins and arteries, may be accounted similar to the waters of the ocean, which experience a regular flux and reflux. It

deserves to be mentioned that this circulation is more rapid in our childhood than in our mature years, which may partly account for the fire and impatience of the former when contrasted with the phlegm of the latter.

The analogies which we have imagined between the earth and the human figure are common to all animals, though not in an equal degree. The more we extend our inquiries into the structure of our bodies, the more shall we have to admire the wisdom of the Divine Artist. The most varied landscape presents nothing equally impressive, notwithstanding the magnificence of its forests, the height of its mountains, the windings of its valleys, or the extent of its plains. Describe a circle by walking round a fine statue, and you will find in it a different view at every change of posture; look at the human figure, whether seated, erect, or extended, on a height or in a valley, and you will discover in every attitude some new source of admiration. The artists, who have been in the habit of delineating it during so many ages, find the same endless variety in its form as the moralist in its mental affections; and it requires the labour of a life to be able to exhibit, in a natural manner, its beauty, its proportions, and its various affections. In regard to animals the case is very dif-

ferent, their bodies being frequently disfigured by hair, feathers, or scales, and their faculties confined to one kind of exertion. Man alone applies his understanding to Nature at large, and alone displays his personal beauty in an unclouded state; he comes naked from the hands of Nature, not that he may be exposed, as some malicious persons have said, to injuries from the elements, but that his reason may be exercised in providing the materials of clothing, in the same way as in procuring food and lodging. Do not the spoils of every animal become subservient to our accommodation, from the lion's skin which covered the shoulders of Hercules, to the transparent thread of the silk-worm which veiled Dejanira?

Observe a beautiful female in a garden gathering fruit and flowers, or sporting in the meadows with her young companions, and new beauties will be discovered in every movement of her head, arms, or hands. See her some years afterwards surrounded by her family, and bearing an infant in her arms, and you will not fail to discover a pleasant subject of contemplation in what is nothing else than the natural attitude of her person. The affections of her mind are still more worthy of attention, and may be traced by turns on her countenance. Candour sits on her fore-

head; conjugal attachment shines in her eyes; modesty marks her cheek, and the maternal smile is on her lips. She speaks, and the ear of the hearer is charmed with the mild sounds of her voice; comfort, hope, content, proceed from her mouth to the heart of her husband and children. Admire no longer the master-pieces of the Grecian sculptors; the Apollo Belvidere is but the first work of Phidias, while the human form is the finest work of Nature. Never did marble receive more than the external part of the human figure at the hand of the sculptor; within it remains lifeless and unfeeling; but woman is alive to the kindness of her Maker, and affords in herself the most affecting proof of his superintending providence. In covering the earth with his bounty, God gave us liberty to enjoy it, but he raised us likewise above this lower world by engraving on our minds an idea of himself; he made his works serve as a model for the exercise of our understandings, that he might approximate us to himself, and teach us that we were reserved for a future life in a higher sphere.

Nature, after affording to man the means of scaling the steepest situations by the climbers and bushes which she produces in these spots, prepared for his repose a soft couch in the grasses of the meadows, and in the moss which crowns the

rocks. It is in such situations as these that he often, when in an uncivilized state, passes the night alone, as when in childhood on the maternal bosom, without experiencing any inconvenience. We who, in these days of effeminacy, have accustomed ourselves to every indulgence, would expose ourselves to rheumatism by passing even a day on a damp spot. Yet the habit of exposure would soon restore our natural temperament. During the revolutionary war the French soldiers made their campaigns, in general, without tents, and passed the night without any covering. It was accounted an extraordinary piece of news to be told in the morning that at night they should take up their quarters in the shelter of vineyards, imperfect as it was; a trench or furrow was their customary abode for the night. This shows that the vapours of the earth are not always so hurtful to us as they are thought. I have seen scorbutic patients cured by putting their bare legs into the pure sand; and I have made personally a trial of it in the calcareous sand of Ascension Island. It is said that, when we happen to be overtaken by mere weakness, we shall, on some occasions, regain strength by breathing the vapour of the ground; a circumstance which may recall to the memory of the

patient the case of Antæus, whose strength returned whenever he touched his mother's bosom.

It is to the bosom of Nature that we mechanically direct our steps in seeking a resting place against vexation. We take a pleasure in a solitary walk along a secluded valley, or between the steep sides of a mountain, as if the retired nature of the scene afforded solace to the distress of our mind. It was beside the borders of the main that Homer represents Chryses lamenting and complaining to Apollo of the injustice of Agamemnon in depriving him of his daughter. It was in a deep grotto that Sabinus escaped, during several years, the vengeance of Vespasian, and received the most tender marks of conjugal affection. It was in going out from that hiding place to the scaffold that the faithful companion of his retreat said, when brought before the Emperor, "I have passed happier days with Sabinus in a cave than you in the enjoyment of day-light, and the lustre of imperial power."

Finally, it is in the bosom of the earth that we seek at last a permanent repose, or rather that we deposit the elements which we received from it. It admits of no doubt that the mass of the globe receives an annual augmentation from the decomposition of human bodies, as well as of

those of all created beings. Geographic calculators compute the total of mankind at nearly a thousand millions, and it is pretty generally allowed that our numbers are in a state of progressive increase. It is computed likewise that an existing generation remains in life little more than thirty years, so that on taking a view of the inhabited world we find that the current mortality is probably not less than 3,600 persons an hour, which is equal to sixty in a minute or one in a second. Every time our pulse beats we may reckon that a living creature has come in and another gone out of the world.

The sun is the primary cause of all the movement of organised bodies in the earth. In considering therefore the rays of his light, which are so visible from a distance on glass at the time of his rising or setting, we may look on them in a manner as the first elements of time; they are rapid as the twinkling of an eye, and a number of them take place in a second. We shall thus arrive at a division of time still more minute than any with which we are as yet familiar.

Whatever may be the origin of our souls it is clear that we owe the relics of our body to the earth; yet, although the same end is common to all, men have adopted very different methods of rendering the last duties to their dead. Different

nations seem to have followed, in this respect, an impression derived from the particular department of Nature with which they happened to be most in harmony. Some, like the Romans, consumed the bodies by fire; the inhabitants of Otaheite dry their dead in the air upon alcoves under the shade of trees. The Hindoos, on the borders of the Ganges, abandon them to the current of that river which they consider as sacred. The ancient Egyptians, on the other hand, covered the dead body with the aromatic resin of trees, wrapped them with linen, and preserved them in sycamore trunks. The Guebres placed them erect in a spot surrounded with walls, and abandoned them to birds of prey. Finally, Pliny observes that no animal, except man, takes any pains to bury those of his own species. But however various may be the means adopted to discharge this final duty, it is clear that our ashes are always re-united to earth. Its whole surface may be said to contain, even to its rocks, the fragments and relics of bodies which once were in a state of animation.

Paris, the city where so many come to learn urbanity and propriety, is, I say it with grief, the place where, of all others, the least regard is shown to the memory of those who once were dear to us. The inhabitants of that vast capital,

occupied with the gratification of a thousand trifling objects, preserve very little recollection of their fellow-creatures after they are gone. Even decency, in respect to the mode of interment, is disregarded; the general place of burying being, as I have mentioned in a former part of this work, those extensive trenches in which are thrown daily, without distinction of age or sex, women, children, and old men, until they are filled and can hold no more. In such a disgusting spot a friend would look in vain for the ashes of his friend, and he would tremble even at approaching these gulfs of death from which noxious vapours are perpetually exhaled.

The case is very different among the Chinese, whose government is perhaps one of the oldest in the world, because it is founded on the laws of Nature. Their tombs constitute a principal ornament of the environs of their cities. Every family possesses as its property a small lot of land in a neighbouring hill, where a tomb or grotto is hollowed out, and the bodies of the family deposited with religious reverence. The entry of the grotto is ornamented with a few trees, which are so far from exhibiting a revolting appearance that travellers often sit down and rest under their shade. When a body is consumed by lapse of time, or by the effect of lime in the soil, the

bones are finally committed to the earth. The nearest of kin comes at the head of his family, and dressed in a coarse linen garment which is tied round his body with a cord, to collect the relics: he deposits them in an earthen urn which he places with those of his ancestors in a certain room of his house. It is there that, according to the expression of Juvenal, he finds urns filled with tears; and he sees at a single glance the remains of those ancestors who have succeeded each other during successive ages. The impression of great antiquity exists as strongly in a private as in the imperial family. It is the custom several times in the year for a family to call by sacrifices and libations on the spirits of their ancestors whom they consider as returned into heaven; entreating them to inspire their living descendants with sound council, and to watch over their lot in life. It is, in a great measure, to these affecting rites, and to these religious impressions towards deceased parents, that the Chinese are indebted for their strong feeling of attachment to their country, and to their living relations. The tombs of the dead may thus be considered as instrumental to the consolidation of their empire, which has now been in existence during so many centuries.

Terrestrial Harmonies of Children.

PRESIDE over the sports and studies of our children, ye Zephyrs, ye Genii, and ye Cupids who diffuse animation over the face of Nature.— Poets and painters have represented you under the shape of winged infants, but your flight is more rapid than thought, and your course extends throughout the air, the watery regions, and the verdant covering of the earth. Every day you build some new palace for the morning in the inexhaustible variety of your shades of gold and purple. Look down with a kind eye on your little brethren who are enjoying amusement, or reaping instruction. They enter on the career of life with smiles and sports; surround them with the charms of friendship and love, until their innocent minds, separated from their worldly accompaniment, take their flight to another sphere, and join your own in heaven.

In treating of the beauties of the human frame, we observed that it contains the finest curves that can be generated by the sphere. In infancy, however, these curves are not displayed in a complete state; they are enclosed in a little body, like the petals of a flower in its bud. It is mental intelligence which seems to give the hu-

man shape its beauty and perfection; it is affection to a mother which excites the first smiles in an infant's mouth; it is the impulse of curiosity that gives motion to its little eyes in their sockets, and gradually leads to the habit of using the muscles of its legs and arms. In whatever age we contemplate the human frame, we shall find that the body is much more likely to receive its character from the mind, than the mind from the body. An effusion of joy is marked by a slight wrinkle in the corner of the eye; but grief, if long continued, makes much deeper wrinkles on the forehead.

Let us make a few observations, then, on the condition of a child in the earliest stage of existence. Its little muscles appear like flower buds yet wrapped in their calyx, and its shape presents a portion of a sphere in all directions. Every member is round, and it is not till after his earliest feelings have begun to display themselves, that its bones lengthen, and that its muscles receive the curve that is most suitable to their respective functions. In treating of vegetables, we observed that whatever is organized with a view to life, takes a direction, as it grows, towards the sun. Yet, in considering that orb as the first mover of all that lives on earth, I am far from saying that it is the author of life. Life

proceeds from a still higher source; from him who has given laws to the sun, and who has distributed to all a portion of existence, which, as soon as it has reached its plenitude in one generation, is transmitted to the next.

The first appearance of a child intimates that it is made for repose, its little round muscles being fitted to serve for cushions, as well as the maternal bosom. Although unable to make use of its little limbs, it can call for aid from others. At six months it makes efforts to hold itself erect, and may, if in health, be then exercised in walking with chairs round a room. It sometimes happens that a hired nurse places her little charge erect in some small cavity under pretence of accustoming it to hold itself upright, but in reality to avoid the trouble of carrying it herself. In this perpendicular attitude, the weight of the infant presses too much on the still tender bones of the *tibia* and *fibula*, which thus become bent. It is imprudent, therefore, to accustom children to walk too early; let us precipitate nothing; premature fruit is often little better than abortive. I have indeed seen in the Isle of France negro children walking along at the age of seven or eight months; but in our climates a child should not be expected to walk before the end of the twelvemonth. The difference in a hot country is

owing, however odd it may seem, to the influence of the sun; to the same influence which calls forth rapidly the activity of the powers of Nature throughout all the extent of the torrid zone; which makes the orange-tree bear fruit twice a-year, and renders young females marriageable at the early age of twelve.

In teaching a child to walk, we should make use neither of go-carts nor leading strings, which, by pressing on their shoulders, are apt to make them high, and which, by accustoming them to receive support, lessens their habit of supporting themselves. A more simple method, which I have seen practised by a country woman, consists in fastening two long parallel sticks to two chairs, and putting the child between the two.—In that situation, he puts his hands both right and left, on the sticks, and walks between the two as in a little gallery, learning at once to keep himself erect and to move forward. It was in this way that my little girl walked at ten months; but one of her supports having been loosened, she fell along with it, and would never afterwards trust herself to the most solid wall, so that she did not walk till the age of fourteen months.

I consider it necessary to educate a child for himself as well as for others, and to form him for solitude before preparing him for society. In

truth Nature gives us the elements in common; but we make use of them separately, each of us desiring to eat, walk, and rest for his personal convenience. How often should we be obliged to forego these gratifications, were we prevented from enjoying them otherwise than in the society and by means of the assistance of our equals! The same holds in regard to our moral gratifications. How different do they not appear in the case of different persons! the patience of a philosopher is cowardice in the eyes of a soldier; a republican and an advocate of monarchy would remain at variance though under the same roof. If a child then be educated only for society, where is he to take refuge, untaught as he is to retire within himself. I am inclined, therefore, to look on the principles of the solitary education of the Emilius of Rousseau, as a proper preliminary for a public course. Let us cover our pupil when in misfortune with the mantle of philosophy, and he will not fail to cast it, when in prosperity, over his fellows.

The great object of private education should be to convince a young person of the existence of God by an appeal to the proofs of it scattered throughout his works. Were the sophistry of the atheist, or the dungeon of the tyrant, to raise in his mind impressions contrary to the belief of

a beneficent Providence, these impressions will be but temporary, and he will find the assurance of contrary sentiments in his own breast. It is this which makes conscience so secure a retreat, and which renders human life, with all its draw-backs, a pleasant career. Without the conviction of a superintending Providence, the inconstant elements, and the orbs which traverse the immensity of heaven, would appear in no other light than as enormous masses moved by blind powers, and always threatening our globe with destruction. But the conviction of over-ruling wisdom keeps the mind in tranquillity, and points out to us a quarter to which we are to address ourselves when in misfortune. It is by arguments directed to this point that the sage succeeds in persuading his fellow men, the legislator in commanding them, and the necessitous in working on their pity. Such a conviction is necessary to every condition of life to render it supportable, and to every nation in the world to keep it united. It was this which supported Scipio when in solitude; Epaminondas, when at the head of the army; Socrates when in a fickle and cruel republic; Epictetus when in thraldom; and Marcus Aurelius when on an imperial throne. An attachment to our fellow men is a consequence of gratitude to our Creator, and the two

may be considered as the polar star, both of our physical and moral existence.

The sphere of our life may be compared to the sphere of the world, and its revolution to the annual revolution of the world round the sun. The elements of the globe repose at first on the terrestrial pole of our hemisphere; the atmosphere and ocean are in a stagnant state, their mists scarcely disclosing the form of land; but so soon as the sun makes his influence felt, the winds and torrents bring down immense quantities of floating ice, which renovate the stores of the sea, and pour forth a supply to the sources of rivers. A quantity of the ice accumulated during winter, sticks fast in the icy zone; another quantity undergoes evaporation in the temperate zone; while a third part, entirely melted, rolls its waters across the torrid zone, where they are dispersed in storms; and finally, another portion of the evaporated store, after rolling across half the world in clouds, becomes fixed in the shape of ice on the opposite pole, at the season when all is darkness there. In like manner the ocean of life carries forward every year a numerous generation, some of which make shipwreck at an early age; others disappear in more advanced youth; a third part, become conspicuous for a

season, but meet a premature end; while the fourth and last division sinks into the grave, after completing the due proportion of years.

How many children and youths disappear from this mortal scene without having completed the natural period of existence! They appear in our horizon like the Aurora Borealis, which is resplendent only for a night. They are in the world like those characters in a drama, who, without appearing on the stage, are the cause of many tears; they are known only by the regret and despair of their mothers. But why should we lament their fate? Should they not rather receive congratulations on arriving in port so soon after setting sail? Death is not an evil:—The life of a child is like the course of a stream, which, after irrigating a meadow, disappears with the snow which produced it. Who knows but the evaporation of the elementary principles of life, may not, like a similar evaporation in Nature, tend to bring animation to other objects. Who knows but the death of the aged may be a return to a new life? Why then should we be afraid of death if our career has been proper, or if we have felt due contrition for our vices? Innocent children need fear nothing; the agents of superstition can alone inspire them with apprehension. It happens

but too often that these birds of darkness hover around the cradle and the tomb of man, seeking an easy prey in the weakness of the young and the dying; but as civilization advances, let us hope that the abuse thus made of religion will disappear.

BOOK V.

HARMONIES OF ANIMALS.

I ADDRESS myself to thee, Brilliant Orb of Day! thou soul of the world, and living image of the Divinity! Inspire me with a knowledge of the order in which thy rays developed matter at the time that they communicated to it colour, shape, motion, and life. The dark planets were stationary in the silent immensity of space; and, had any distant gleam, arising from the stars, exhibited a transient view of them, they would have appeared buried in the bosom of darkness, like vast tombs covered with the gloomy mantle of night. But thou didst shine forth; the earth, attracted by thy rays, drew nearer to thee; its atmosphere was called into life and action; the winds of the south blew; the ice of winter was melted, and the globe assumed its present form. The division of night and day arose from the rotatory motion of the earth; summer and winter from the alternate vibrations of its poles; years

and ages from its circular movement around thee. The sister planets took in like manner their stations in thy system, and completed the harmonies of the universe.

The waters of the earth, liquefied by thy warmth, now carried fertility in all directions: the ocean retired within its bed, and left not merely mountains, but vast tracks of levels open to coming generations. Rivers flowed over the newly discovered surface, and carried to the ocean the tribute of those waters which they owed to evaporation from it. In progress of time, the dark rocks put on a mossy covering, and the valleys assumed the aspect of meadows; hills were crowned with orchards, and steep mountains saw majestic forests proceed from their sides. The algæ and fuci floated on the sand banks, at the will of the azure waves. Every vegetable bore its seed, its grain, or its fruit. Next came the animal creation; clouds of birds began to fly through the air: legions of fishes to swim in the water, and vast herds of quadrupeds to move along the ground. How delightful was it to see the feathered tribe, resplendent with varied colouring, perch on the summit of lofty trees, and send forth to a distance the sounds of joy and gratitude. All nature became animated, and every part displayed the marks of joy and love.

Why, it may be asked of me, do you attempt to extend your ideas towards the future and the past, both of which are unknown to you? Content yourself with the present, of which, be assured, your knowledge is not complete. True; but who can have narrow views in so vast a world, or an unfeeling heart amidst the evils of this lower sphere, and the blessings which he considers likely to come down from heaven. Even an insect is not totally insensible, but will be found to carry its solicitude beyond its own horizon, and the passing scene of its existence. In spring it hums in the midst of flowers; it soon after deposits its eggs, and gives its young a fruit for their cradle. It even extends paternal foresight to the winter, which, perhaps, it is not destined to behold. Its instinct passes to its posterity from generation to generation, and may be said to remain in perpetuity. Does not such an example justify the solicitude of man to seek, in the experience of the past, a fund of provision for the future?

The present exhibits the signs both of what has been, and of what we may expect in future. The earth presents itself to us as she appeared in the early ages of the world, showing on one hemisphere the gloom of night and of winter, at the time when the opposite hemisphere displayed

all the harmonies of light and life. The south pole, on removing to a distance from the sun, acquires a progressive addition to its mass of ice; it atmosphere, filled with the vapours of the surrounding ocean, discharges vast quantities of snow on the frozen mass, the height of which is probably much greater than we can figure to ourselves from any thing which has fallen within our personal observation. Captain Cook approached the icy territory of the South Sea in summer, and compared the masses he saw to lofty promontories, although the latitude in which he was was not within five hundred leagues of the pole. These icy masses rise above the floods like mountains of crystal; in winter they acquire a great extent, and in summer their fragments look like floating islands, and are found even in the forty-second degree of latitude, of more than a hundred feet of height above the sea. But in winter they are immoveable, and the ocean in this direction is frozen into vast plains. Immense ranges of snow cover the tracts of land bathed by its waves; such as the uninhabited islands of La Chandeleur, the shoals of Terra del Fuego, the rocks of Cape Horn. On the loftiest top of the Cordilleras, the snow extends to the middle of South America, where it resists all the heat of a vertical sun. What creature could continue to

live without the solar rays in that southern polar region, where, even in summer, the intensity of the weather may prove fatal, as was experienced in the case of two unfortunate seamen in the vessel which carried Sir Joseph Banks. Even the petrels and penguins must at this season fly from these frozen seas and petrified lands. What vessel could sail in winter under a sky shrouded with continual gloom, and lighted only by the glimmer of stars, of the moon, or the blue flame of the Aurora Borealis? It is possible, however, that Nature, in the extent of her beneficence, may have employed some assuaging means in that frightful climate. The tepid currents of the ocean of the torrid zone must necessarily have the effect of tempering the atmosphere, while Winter's tree, rich in aromatic perfume, and clothed in ever-green foliage, is found to shadow the valleys of Cape Horn.

Let us quit, however, the south pole, which, in our month of May, seems the grave of Nature at the time when its northern antipode may be called its cradle. The sun, in the midst of his course through the torrid zone, sends forth his rays, by night as well as by day, all around the cupola of ice which crowns our hemisphere; he covers its summits with his golden and purple tints. The south wind comes from the burning

bosom of *Zaara*, and lends its aid to demolish the immense masses of ice raised in the course of the winter. The tepid waves of the southern seas communicate a portion of warmth to the northern waters. Vast rocks of ice, supported by feeble pedestals, are suddenly detached from the mass, and fall into the water with a far greater crash than those oval arches which are precipitated from the glaciers of the Alps into the adjacent valleys.

Carried along by the polar currents, these masses move southward, and become completely melted in temperate latitudes. Some of them, like those which Ellis, the well known navigator, met with, are 1500 feet above the surface of the water, and more than a league in circumference. Streams are seen to fall in cataracts from their summits; and the quantity of water, added by their melting to the ocean, may be compared with the volume thrown in by such rivers as the Rhine and the Danube. They are frequently surrounded by moving fields of broken ice, extending many leagues in length and breadth, like that which opposed the final attempt of the intrepid Cook. The northern strait which separates Asia from America is sometimes frozen over by accumulations of ice. At other times, the masses are seen piled above each other, and exhibiting, with their

crystals, a thousand fantastic edifices, obelisks, arcades, Gothic temples, Chinese palaces, resplendent with the blue of the sapphire and the green of the emerald, Meanwhile the ocean, rolling like an immense river from the north, drives them to the south. It circulates around the whole globe, and carries the freshness of the north to the torrid zone, and the heat of the latter to the frozen regions of the south pole. The last islands of the north, known by the names of Vogelsang, Clover, Cliff, Hackluyt, raise their dark and humid shores in the midst of the rolling waves. The earth lays open to the sun all the exposures and all the products of the northern hemisphere. The orb of day communicates warmth to them by reflecting his rays, even through fogs, in rainbows, in luminous rings, and in dazzling parhelia. The azure sand-banks are covered with sea-weed, and the red granite with moss and verdant lichens. Troops of rein-deer rush shouting with joy to these new meadows; while birch-trees with a foliage of tender green, and dark firs with stamina, surround the extensive lakes of Lapland. Flocks of aquatic birds come from the south to build their nests in this northern clime; while, in return, hosts of fishes descend from the neighbourhood of the pole, approach the western coasts of Europe, and are even found in the rivers of

the south. Animal life, diversified under a thousand forms, is diffused throughout our hemisphere, from the sands of the burning Zaara, where the hideous cerastes is found with his no less hideous female, and where the panther is heard to howl in the night—from Zaara, all the way to the strands of Spitzbergen ; those strands where the sea horses, arranged in regular order with their young, and the fierce white bear, dispute with our bold navigators the last limits of the empire of day.

But it is particularly in our temperate climates that the month of May presents the most gratifying harmonies of animal life. The morn, crowned with roses, opens in the heavens the gates of the east; the zephyr rises in the bosom of the sea, and causes to undulate its azure surface, the myrtles of its shores, the flowers of the meadows, and the cowslips sparkling with dew. Legions of insects, covered with shining coating, arise from their subterranean retreats, and, rejoiced to behold the light, spread themselves, humming with joy, on the various plants destined for their support. The hills resound with the bleating of sheep and the valleys with the lowing of oxen. On the borders of woods, the bull-finch, hid in the white thorn, delights, by his sweet warbling, the companion of his

nest; while the early lark looks down on his partner from the sky, and makes the groves resound with songs of gladness. The sun comes forth in his splendour, and calls new objects into life at every step of his progress. We hear, throughout the atmosphere, on the surface of water and in the bosom of rocks, voices that call and voices that reply. Night even has her concerts. The nightingale, fond of solitude and silence, chants his melodious strains by moonlight. In vain does the envious cuckoo interrupt them with his monotonous cry; the contrast serves only to redouble their delightful harmony. The herald of spring makes the distant echoes repeat his joy, his grief, and his loves; all is animated by day as by night, in light as in darkness. Gentle murmurs are re-echoed by the moss, the reed, the orchard, and the forest.

Vegetable treasures were evidently created for the sake of the animal kingdom. Were the earth to produce nothing but plants, it would be in vain that the flowers adorned the meadows with their varied colouring, and that the fruits, suspended from the orchard, exhaled their perfumes to a distance. There would be no eyes to see them; no smell to scent them; no taste to relish them; the world would soon be covered with decayed grass and dissolved fruits. The forests,

overthrown by the lapse of ages, would present nothing but parasitic plants growing on the fragments of their trunks. It would be in vain that a few trees, rising amongst the surrounding ruin, stretched their heads towards the sky, and shone with the brightness of the dawn; in vain would the winds wave their tops adorned with all the pomp of vegetation; their gloomy murmurs would not be sufficient to convey an impression of a superintending Providence, when the sun was seen to rise on beings devoid of sensation, and when nothing but the stillness of death proceeded from the vegetable kingdom. In such a state of things, even the convulsions of the globe, its broken rocks, its opened mountains, would present nothing but the wrecks of matter; while the disorder apparent in particular departments of vegetation, contrasted with the want of object in a general view, would suggest the idea that the world was the work of a being endowed with immense power, but limited in point of knowledge. The sight of such discordances would create in the mind of man an apprehension that this being might introduce confusion into the primary laws of the elements; and, in our terrors for our own existence, we might be inclined to admit, as a primary principle, rather a blind and

inconstant motion in the universe, than a capricious divinity in Nature.

Happily, however, the kingdoms of the earth are not abandoned to the sport of chance nor to the monotonous laws of blind motion. Infinite wisdom harmonizes the destiny of all their parts; creating vegetable products to meet the wants of animals; making the birds to fly in the air, the fish to swim in the water, the quadrupeds to walk the earth. Meadows are allotted for the pasture of four-footed beasts, the fruit of trees for birds, the products of the main for fishes; even the ant consumes the grains of the lofty cypress, and the worm with its borer brings into powder the knotty trunks of the oak overturned by the wind.

The animal kingdom is of a decidedly higher order than the vegetable. The butterfly is more beautiful and better organized than the rose. Observe the queen of flowers formed of spherical portions, tinged with the richest colouring, exhibiting the beauty of contrast by its green foliage, and balanced by the zephyr; still the butterfly will be found to surpass it in harmony of colouring, shape, and motion. Mark with how much skill are framed the four wings with which he flies; the regularity of the little scales which cover them like feathers; the variety of their

brilliant tints, his six feet provided with little claws, by means of which he resists the wind when retired to rest; the round trunk with which he sucks his nourishment in the bosom of flowers; the antennæ, exquisite organs of touch which crown his head; and the admirable network of eyes with which it is surrounded in extraordinary numbers. But what render him decidedly superior to the rose, or to any vegetable, are his senses of seeing, hearing, smelling, and tasting, along with the principle of life, in a soul accompanied with instinct and sensation. It is to afford him nourishment that the rose opens the nectarine glands of its bosom, it is to protect his eggs, fastened like a bracelet around its branches, that it is surrounded with thorns. When a child runs to seize it, the butterfly has thus time to escape, to rise in the air, to re-approach its little pursuer, and finally to take its flight towards other flowers, where it may find a more secure retreat.

Here I may be stopped by a cold inquirer who may say: "The Almighty Being is doubtless of unbounded intelligence; but can he be equally good, since he exposes to alarm, and to death, an innocent and sentient creature?"

Death, it may be answered, is a necessary consequence of the enjoyment of life. If the but-

terfly were not to die, were he to live only the ordinary age of man, the compass of the earth would not be sufficient for his posterity; but he lives without fearing death, and dies without regretting life; he hovers in all directions without suffering disquietude from the treacherous ambush of the spider, or from the approach of the swallow, both destructive enemies to his species. Little does he concern himself with his good or bad prospect for the approaching day. When the rainy Hyades bring back cold and the southern blast, he is not grieved at the short duration of his career; but consigns to Nature the care of his progeny which he is destined never to see. He is content with his lot, having fed on flowers, and having lived until the sun was ready to enter the region of darkness. Finally, he seeks the shade at the bottom of his favourite plant, and stretching out his wings, while he fixes his little feet in the ground, he expires in an upright position.

We shall now cast a hasty glance at the faculties of the animal kingdom. Naturalists of too high character have thought proper to confound them with those of the other kingdoms of Nature. According to them, there exists nothing but shades and slight differences between the mineral, the vegetable, and the animal kingdom; according

to them, an oyster differs from its shell only by modifications, and man, whom these gentlemen class among animals, is himself nothing but organized matter, subject to the simple laws of physical bodies, in which attraction, in their opinion, is the only mover. As to elementary powers, they have thought proper to leave them quite out of their system, so that the temple which they pretend to raise to Nature wants both a top and a foundation. Where would they then place those moral laws which ought to regulate human societies, if they can see nothing in the universe except physical laws? We shall see, in the course of this work, moral harmonies regulate the physical, and unite them in a vast sphere around man who is their centre and principal object. Meantime, we shall proceed to lift up a corner of the veil with which materialism has covered the sublime destiny of mankind.

All the kingdoms of Nature have a character peculiar to themselves; even their physical qualities go on in progressive augmentation and multiplication. I do not undertake to analyze their principles; to understand them, and to distinguish one from the other relatively to our wants, it is enough that we compare them by their effects. Solar power occupies unquestionably the foremost rank, whether it be absolutely the origin of the

products of Nature, or whether its functions have been confined to giving them colour, shape, motion, and life. As far as our limited minds can form an idea of solar power, we must pronounce it self-existent; at least by no means dependent on the powers of our globe in the way that they are dependent on it. We can easily conceive a sun without a world, but not a world without a sun; at the same time, I cannot form an idea of the properties of the orb of day without tracing their relation to those which it communicates to other powers, and the latter can be characterized only by combining them with the action of the sun. It is by their harmony with the sun that I perceive each of them, from the aërial to the human power, become distinct from the other, and increase its faculties. It is likewise by means of senses connected with such qualities that man is enabled to point out their differences.

Air appears the simplest element of our globe. Were we buried in profound obscurity, we should breathe it without having a knowledge of any of its qualities; but no sooner does the sun rise than the atmosphere is dilated, breezes blow, and we are enabled to conclude that the air is transparent, fluid, and susceptible both of compression and dilatation. This is nearly all that we can be said

to know of it. Some naturalists add that it is composed of branchy and ramified particles, but I should rather think that its component parts radiate round a centre, as far as we can judge by the figure of snow and freezing water exposed to its operation; if indeed these radiating forms do not rather belong to the principles of water.

Water possesses qualities of a more marked character than air. Its natural state is understood to be solid or frozen, and its fluidity is said to be derived from the action of the sun. By conveying warmth to water, the sun not only makes it melt, but brings it into vapours by means of air. He decomposes his rays into a thousand colours on this evaporated water, as we see in the rainbow which comes forth in showery clouds, as well as in the clouds which accompany his rising and setting.

The earth combines the qualities of air and water, and joins to them others peculiar to itself. When reduced into powder, it becomes volatile, and susceptible of expansion and compression. It is transparent as ice when in the state of crystal; it then decomposes the solar rays and becomes liquefied, like water, by a concentration of the fires of that orb in a burning mirror. The earth contains in her bosom a multitude of opaque fossils, the colours and the shapes of which are

of infinite variety. Of these the principal are the metallic substances, the characteristics of which are weight, electricity, hardness, ductility, and brightness. Some, like gold and silver, partake of the splendour of the sun and moon, and seem to owe their existence to the operation of the rays of these orbs on the earth, in a way incomprehensible to us. Gold, in particular, is ductile, as may be seen by the leaves and wires manufactured of it to an almost indefinite degree of thinness. When harmonized by galvanic experiments with silver or other metals, it produces, on the nerves of animals, even after their death, electric effects similar to those produced in them during life, by the combined rays of the sun and moon. Gold is found only in the torrid zone, the portion of our globe where the solar rays act with greatest effect.

The vegetable kingdom receives, as we have seen, all the qualities of the preceding departments of Nature, by means of air and water. These elements it is found to appropriate to itself by the colour and shape of its fruit and flowers, and even by mineralizing processes, some of which are tolerably understood, particularly those of iron, which we find in all the ashes of vegetables. To these we are to add a number of other qualities received principally from the sun;

such for example as taste and perfume. But they differ essentially from minerals by the five faculties of life; I mean organization, nutrition, love, generation, and death. The elementary powers possess nothing but permanent existence modified in different ways; but the vegetable kingdom possesses life, the principal characteristic of which is the power of propagating and reviving. Still there is, as we shall see presently, a radical difference between vegetable and animal life.

The most simple vegetable seems to me composed of a great number of similar vegetables collected under one covering. A plant is organized like a polypus; each of its woody or nervous fibres seems to be a vegetable which maintains a correspondence with the others from the roots all the way to the leaf which it nourishes. The proof of this will be seen in its roots, on cutting any of which you infallibly create a languor in the branches dependent on it. If you cut off the branch of a tree, and replant it carefully, and in a fit season, another tree will spring up; you may even produce it again, as in the case of the willow, by cleaving it in two. Life, in this manner, appears disseminated throughout every part of a vegetable; a portion of its inside may be destroyed without injury to the whole; a

tree with a hollow trunk may still display a thriving foliage.

These remarks are not applicable to any department of the animal kingdom. Although the muscles of animals are composed of fibres and sinews which keep in motion for some time after death, the whole form only one united and indivisible animal. A vegetable may be said to multiply itself in its bark; a grove may be planted from the cuttings of a willow; but what can you do in that way with the limbs of an animal?

Another proof that a vegetable contains a complete vegetable in each of its fibres, is that it produces in its branches a number of flowers which appear to be nothing else than the sexual parts of the fibres arrived successively at their full growth. In an annual plant, the flowers appear after a certain number of lunar revolutions; but in a tree, the new wood gives no flowers, and the flowers of the old wood change their place from year to year. This is probably the reason that a tree, when it produces a number of flowers, sends forth no shoots, and that when it sends forth many shoots, it produces no flowers. We may conclude from this that the soli-lunar harmony which produces its annual rings, tends to form, in the inside, male and female fibres which

subsequently throw out flowers. These flowers do not re-appear the succeeding year in the same spot, because the fibres which produce them are lengthened by the annual ring and increase of the wood, so as to terminate at other points of the bark. Finally, these flowers cannot appear on the new wood of the year, because it is not at its maturity. The inference is that gardeners often do wrong in cutting the annual shoots of young trees, which subsequently carry neither fruit nor flowers, because this new wood has not had time to arrive at the term of its fecundity. The most simple way is to let it grow on; it will then bear fruit, as I have myself experienced. I have had very vigorous pear-trees more than twenty years old, which had never been in flower because the gardener, constant in an adherence to old rules, had cut off in autumn the chief part of the branches which had shot forth in spring. At last I succeeded one year in preventing this fatal sacrifice; my trees became covered, as usual, with shoots full of juice; after having spent their first fire, the shoots stopped during the second year, and produced fruit-bearing branches covered with large buds, which in the third year produced flowers and fruit.

I know hardly any vegetable which produces only one flower; whereas an animal has, as is well

known, only one sex. When the two sexes happen to be united, as in the case of snails, the position of the sexual parts is invariably the same. The sinews and fibres of the muscles of an animal all co-operate like his other organs to a single action, whereas the fibres of vegetables have detached and particular actions; acting in common only by their accumulation. A vegetable wounded in one part thrives in the others as before, while an animal feels the stroke throughout his whole frame.

Some theoretic reasoners may say that the nervous fibres in an animal are as many distinct creatures united under the same skin, because animals, and in particular our own species, are subject to a variety of sensations, some of them of an opposite character. Be this as it may, there will always exist a great difference between the composition of vegetables and animals; the former has, in general, such a mixture as to contain young and old at the same time; some dating only a fortnight back; others in a twelvemonth or more. The bough of a tree is younger than its stem, and its alburnum, or soft wood, is of later date than its trunk. A tree, when in decay, carries the marks of age in its heart, and of youth in its top; both are apparent in its roots and in its bark. The increase of its parts is evi-

dently dependant on soli-lunar harmonies; its annual rings subdivided into lunar circles, affording, as we have already said, a proof of this. Now it would be superfluous to enter on any argument to show that an animal was not formed of an assemblage of living creatures. The periodical renewal in some cases of the substances which compose his bones, a thing proved by the bones of fowls which live on madder, subjects him, doubtless, to the same planetary periods as the vegetable; but the decay of his parts takes place all at once, so that he differs from the vegetable in the material point of having the whole of equal age.

Similar differences exist between vegetables and animals in regard to the disposition of the organs. Animals have theirs generally divided into two equal parts; an arrangement evidently suited to substances intended for change of place; but in vegetables this equilibrium is apparent only in the leaves, flowers, and seeds. We find it, in truth, in the stalks of grass; but the major part of trees and bushes do not exhibit it unless in a very singular manner. In the organs of nutrition and generation the difference is still more perceptible. Vegetable products have their absorbents or roots below, and their sexual parts or flowers above; while animals have the mouth

above, and the sexual parts below. The former bear their fruits outside, the latter engender within. At the same time, vegetables are not animals inverted, as some theorists have thought proper to allege; for they have not the faculties or organs indispensable to the existence of animal life. Without dwelling on the obvious wants of a head and heart, a radical difference will be found to exist in the viscera, as well as in other organs, of which we shall treat presently.

We have seen that the vegetable kingdom combines in itself the faculties of the three elementary kingdoms: among others, the elasticity and colour of air, the motion and circulation of water, along with the terrestrial forms on which we have dwelt at some length. We have likewise shown that the vegetable kingdom had a kind of life or power, of which the harmonies are organization, nutrition or growth, love, generation, and death. The animal kingdom unites all those harmonies, and joins to them animal life; a power divided into sensitive, intellectual, and moral faculties. Each of these faculties has its harmonies, of which we shall now proceed to give a sketch.

The sensitive faculty is provided with five principal organs; those of seeing, breathing, drinking, touching, and tasting. They are connected

respectively with the five primary powers already enumerated; the sun, air, water, earth, and vegetables. Each of these organs has harmonic effects, by which I mean active and passive, or positive and negative. Thus, sleeping and waking are connected with sight; the voice and hearing with respiration; drinking with thirst; rest and motion with the touch; and finally, the taking and digesting of aliments with taste. I am the more particular in enumerating those minute and apparently unnecessary distinctions, that the reader may have a clear impression of the difference between the animal and vegetable kingdom. The latter, as is well known, offers nothing of the kind, neither in the organs of plants nor in their functions. Although some plants, like the tamarind, shut their leaves or flowers in the dark, it is for the purpose of sheltering them during night from damp; and when, as in the case of the dandelion, a similar closing takes place in the day-time, it is as a protection against the heat of the sun. It would, however, be an abuse of terms to say that on such occasions the faculties of plants are suspended, like those of animals, in sleep; on the contrary, they are then in great activity, vegetation going on as expeditiously as when exposed to the sun and air. Sleep belongs then, not to the vegetable, but to the animal

functions, and suspends only intellectual and moral faculties.

Vegetable products are, in like manner, wholly without the respiring power of animals. It is true they aspire and emit air; but they have neither a larynx to produce sound, and still less the power of hearing such sounds; whatever noise is produced through their medium, arising from the action of the wind, or from some other extrinsic cause. Similar remarks are applicable to their relation with water; they absorb it as they do air, but without digesting it. Nor must the example of the sensitive plant be admitted as an argument of their having any consciousness of touch; for, although that plant shuts its leaves when touched, its motion is strictly passive, and is produced by an external cause. It seems very likely that the hedysarum gyrans, of Bengal, owes the oscillating motion of its foliage to the combined operation of air and heat, in the same way as other vegetables owe to that cause the motion of their sap, and animals that of their blood. The latter, however, have the principle of motion in themselves. The insect, whose body is covered with scales devoid of sensation, has antennæ in which reside the organ of touch, perhaps of smell, and which direct his motion forward: these may be called his guiding

compass. A number of scaly fish have cirrhi which answer the same purpose. The oyster, whom some naturalists look on as an intermediary between a vegetable and an animal, possesses the power of moving its lips; it opens and shuts its shell at pleasure. It possesses also the power of loco-motion, being by no means incapable of changing its abode, and it is believed that even the species of oyster which adheres to rocks is capable of swimming soon after its birth. They make choice of uneven surfaces, and fix their irregular shells with as much skill in the bosom of tempests, as is displayed by bees, in regard to their hexagonal combs, in the tranquil abode of forests. The mason-work of this kind of oyster is so firm, as to admit of being detached only by taking part of the rock along with it. Finally, vegetables derive their nourishment from the elements, without having the excretory organs of animals any more than their faculty of taste.

The intellectual faculty is of a much superior description to the sensitive. It combines three qualities: imagination, judgment, and memory, which may be said to preside over our different senses. Imagination receives an idea of objects through the medium of sight and hearing; the judgment compares their relations by means of taste and touch; while memory preserves the re-

sults of imagination and judgment in order to make them the basis of experience. Memory embraces the past, judgment the present, and imagination the future. These qualities extend to the relations of things, times, and places, agreeably to certain radiations assigned to each kind of animal; man alone embraces the whole. Yet, though their functions be separate, they act in concert, the smallest insect making use of the whole together or separately, whether he be called on to exercise his eyes, his wings, or his feet. The seat of instinct is in the animal's head, as well as the origin of his sinews, and of the sensitive faculty which they put in motion.

Vegetable products possess, then, nothing fit to be compared to the sensitive and intellectual faculties of animals. Yet some philosophers, among others Descartes and Malebranche, have presumed to rate the animal below the vegetable kingdom. They think proper to assert that animals are passive machines, and that it would be wrong to say the same of vegetables, who they pretend to be endowed with real life, inasmuch as they are capable of propagation. When Malebranche was desired to account for the cries of a dog when struck, he thought proper to compare them to the sound of a bell, when struck in the same manner. To prove this, he one day, in the

heat of argument, unluckily killed by a kick his own bitch; and Rousseau, in adverting to this cruel imprudence, said to me, "When we begin to reason, we cease to feel." I repeat this expression, although quoted elsewhere, because it throws a great degree of light on the nature of the soul of beasts, and on ours, as far as their properties are in common. It shows that our soul has two very distinct faculties, understanding and feeling. The former arises partly from experience, the latter from the fundamental laws of Nature. Both are in harmony in animals, and direct them towards a good end. But when our understanding is made to seek a vain support from theories, and to separate itself from feeling, which is the expression of the law of Nature, it may be instrumental in precipitating dignified and mild characters into the most absurd acts of cruelty. No doubt Descartes and Malebranche fell very unnecessarily into the mistake of arguing that beasts were conscious of nothing but simple attractions; for a very slight experiment might have undeceived them. Put a sheet of paper between a loadstone and a needle; the latter will not turn to right or left in quest of the loadstone, but will proceed towards it by a straight line. Put the same impediment between a cat and a mouse, and you will see the cat run round the paper in

quest of her prey. Is it not then clear that the cat exercises her instinct;—an instinct which is very far from being the consequence of simple attraction, or of a magnetic vortex?

But the soul of animals is gifted with a faculty of more importance than its portion of sensation or intellect; it has a kind of moral faculty. Were not this the case, it would neither have will nor design, and would experience, without any effect, the impression of the sensitive faculty. By moral faculty I understand that which constitutes the habits of an animal; that which gives a cat a different character from a mouse, and a wolf from a sheep. It is different in every genus of animals, and even in their species: it unites three qualities—instinct, feeling, and action.

Instinct consists of the pre-sensations of an animal, or of a previous sentiment of what is suitable for it. By means of it the young, while still in the mother's nest, take the alarm at a noise, or at the menace of a blow, although they do not know the injury by experience. It is by this previous sensation that they suck the breast, walk, leap, crawl, and call out for relief. They are indebted to it likewise for the consciousness of the organs and members of which they make use. What a length of study would it demand in an anatomist to acquire scientifically the know-

ledge which Nature has granted to animals by instinct. The Duverneys and the Winslows confessed, at the end of a studious life, that they had attained little more than an outline of the anatomical science. For my part, I consider man, though full of school knowledge, so limited in what regards Nature, that he would never have suspected the power of wings in facilitating the flight of birds, had he not seen it practically exemplified. Birds, however, taught by instinct alone, derive from this admirable machinery a result which in itself is as surprising as the workmanship of their bodies.

Animals are indebted to instinct, likewise, for a presentiment of their natural wants in other respects. A spider, after coming out of its little egg, does not need to wait till it has seen a model of a web before weaving its transparent workmanship; it is seen at an early age crossing the threads, contracting them to try their strength, and doubling them where it is necessary, having a presentiment that the flies, which it has not yet seen, are destined to be its prey; that they will be caught in its web, and that the struggle may be such as to call for a certain degree of strength in the texture of the materials. Finally, there is no animal without a presentiment of the mode of life and of industry, which it is destined to exer-

cise, along with the different ideas connected with it. Nothing therefore seems to me more erroneous than the school axiom, *Nihil est in intellectu quod non fuerit prius in sensu.* So far from this, we see instinct communicating to animals the first use of their senses, and giving them ideas which they cannot have acquired by experience. I cannot help thinking Mr. Locke in an error when he asserted, agreeably to the school doctrine, that there was no such thing as innate ideas; the study of the nature of an insect would have soon shown him the contrary. Rumour says that his French translator stated this objection to him, but without effect; it is even added that it put him quite out of humour. He was not aware that, by refusing innate ideas to man, he was furnishing arguments to anarchy and materialism; yet he ought to have felt that on a future day a conclusion would be drawn, not merely from his reasoning, but from his example and authority; that, since man had no innate ideas, all those which he acquired must be conventional; and that, if notions of morality were thus arbitrary, the result would be that we are formed to act our parts in life without the benefit of directions from Nature. Of his followers, some conclude that physical laws only are to be obeyed, and fall accordingly into materialism; while

others entertain distrusts of a nature indifferent, as they imagine, to their moral comfort, and allow themselves to be overcome by superstition; that is, by litigious, inconstant, and arbitrary notions of religion; without considering that the same hand which has provided so liberally for the supply of their physical wants, was little likely to neglect them in a moral view.

Had Locke bestowed a momentary reflection on the innate ideas of animals, he would have recognized their existence in every part of the world; he would have been satisfied that it was by means of them that a caterpillar, coming out of its egg, quits its original branch, and seeks pasture on a leaf which is as young as itself. He would have accounted in the same way for this insect choosing subsequently a retreat under a branch sheltered from wind and rain; for its weaving a shell with admirable skill for its own abode when in the state of a chrysalis; and for its leaving a little opening to get out when metamorphosed into a butterfly, although it can at that time have had no knowledge of either change from experience. A mind like Locke's could not fail to have contemplated with admiration the regularity of these operations, as well as of those of the insect in its future condition of a butterfly. After creeping a long time like a worm, it is, all

at once, provided with four splendid wings; it skims along the air, and sports with the winds without any previous instruction; it alights on flowers; sucks the honey from their nectarine glands, so long unknown to our botanists; follows through the air a little female, previously unknown to it, and often of a different colour, but invariably of its own species; finally, this female deposits its eggs, not on the frail leaf where she has lived herself, but on a permanent branch, where they may brave the injuries of a winter, which however she has not yet experienced.

Such considerations as these could hardly have failed to suggest the idea of man having, in like manner, his innate ideas. Has not the new-born child some kind of pre-sensation when it sucks its mother's nipple and extracts its milk? It discovers, after the lapse of a few years only, a presentiment of the kindness or ill-nature of those around it, merely by their looks. A physiognomy is called happy because it announces beneficence in characters that require no description to make them intelligible. It is thus that a lamb, actuated by pre-sentiment, never fails to take refuge beside a dog at the approach of a wolf, although the two animals are of the same genus, and not dissimilar in appearance. An infant dis-

covers a social instinct when, without knowing the causes of the joy or grief of its comrades, it laughs on seeing them laugh, and weeps on seeing them weep.

The followers of Locke might be farther combated in a variety of ways. After arguing that men and animals have innate ideas, we might attack their system of acquired ideas, by showing that the latter are only consequences and extensions of the former. It is on an innate instinct of each species that the character, the industry, the manners, and the physiognomy of animals depend. The parrot, accustomed to live on nuts, has a very different appetite and taste from a bird of prey, although, like the latter, it has claws and a sharp beak. It takes a pleasure in coming near human habitations; and, by way of making it a welcome visitor, Nature has clothed it in the richest colouring, and gifted it with the power of imitating speech. Instinct is permanent in each species of animal, like the germen in each species of vegetable; the course of life serves only to draw out and extend both. The oak, with its strong and spacious boughs, has been once contained in an acorn; and the nightingale, with all its delighful singing, in a little egg.

But if that which is instinct in animals be given to our species in the shape of innate affec-

tions, which exercise an influence during our whole life, the conclusion is that our life is but a developement and expansion of them. It is these affections which, when our situation happens to be at variance with their dictates, maintain their ground with great firmness, and produce a powerful struggle within us. But when they display their influence, under favourable circumstances, they are found to call forth unusual talents, and a power of exertion of which we were unconscious. It is thus that we sometimes see, in the midst of a forest, a beautiful liana in flower; or a majestic cedar, the seeds of which have happily been sown on a favourable soil. It was thus that Nature inspired the soul of Homer with the genius of poetry; Raphael with that of painting; and the ill-fated Columbus with a passion to prosecute distant discovery. These great men succeeded, like many others, notwithstanding the neglect and even opposition of their contemporaries; but the number of such examples would, no doubt, be much greater, had not talents often come forward in an ungrateful land, and gone to waste like seed dropped on a rock.

It is fit, however, to add that a very marked difference exists between the instinct of the most sagacious animal and the faculties of the most uncivilized man. The former can never come the

length of making use of fire, of cultivating, even in the rudest manner, the ground, or of imitating the works of Nature by almost any kind of invention. The impression of the Divinity is found among every people in the globe, and cannot be the mere result of a contemplation of the beauty of the universe, since animals who, like ourselves, are admitted to that spectacle, never discover any religious impression. May we not therefore conclude that the impression of religion is an innate sentiment in man, in the same manner as particular instincts are innate in every species of animals? Our farther inquiries will show that man owes to this fundamental impression those ideas of virtue, glory, and immortality, which are the prime movers of all human societies.

Locke would probably have pursued a similar mode of reasoning, had he first occupied his mind with the nature of animals, vegetables, and elements. To study the great edifice of the world, it is well to begin by its lowest compartments.

After giving a sketch of the instinct of animals, we shall proceed to treat of the feeling engendered by it; meaning by feeling, in their case, a sense of what suits or does not suit them. Instinct seems to have its seat in their head, and feeling in their heart. We might proceed to illustrate this by all the modifications which philosophers

have used in such disquistions, and often, it must be added, without any definite plan. The ancient philosophers, in analyzing the human mind, were in the habit of dwelling on three characteristics; desire, anger, and reason. Descartes rejected this division because the soul, he said, had no parts, and he substituted six primitive passions, admiration, love, hatred, desire, joy, and gladness. In the sequel he made large additions to the list, enumerating esteem, contempt, courage, shame, hope, and fear, as derivatives of the former. By this hopeful course he increased very considerably that confusion with which he reproached the ancients. *He did more*; —by paying very little attention to the rational faculty of man, and by deriving the functions of his soul from animal spirits by an unintelligible physical process, he gave to man only passions common with animals, whom he regarded as little else than machines. Besides, how could he put admiration on the footing of a passion like love? Can we be said to have as strong a natural inclination to admire as to love? In my opinion, admiration is nothing but the accidental surprise of our understanding on the occasion of an agreeable discovery. Descartes, in treating of primitive passions, takes no notice of terror, nor does he consider aversion in opposition to desire. He

was not aware that the faculties of the soul are twofold, like our members and our organs; that some, like love and hatred, are in contradiction, while others, like intelligence and reflection, harmonize together. Our soul has been said, by some fanciful reasoners, to partake of the same harmonies as our body, where the lower parts form a contrast with the higher; while the lateral parts possess a coincidence and an equipoise. Be this as it may, it is clear that joy and sorrow, esteem and contempt, hope and fear, are rather the effects of passions than passions in themselves.

The want of order in several systems relative to the human soul may be ascribed to the circumstance of the authors of these systems not having studied animals before attempting to study man. The true plan is to begin with the simple before proceeding to the complex. In my opinion there is only one feeling in an animal, a feeling resulting from his instinct, and which may be defined a desire of whatever suits him, and an aversion to whatever is of a contrary character. From this source, simple as it is, are to be derived all the innate sympathies and antipathies of animals. The portion of intellect possessed by them is the cause indeed of various modifications of these sympathies or antipathies.

When imagination actuates them, it tends to carry them towards the future, and to produce the impression of hope or fear. When judgment (as far as they are capable of judgment) operates, the result is a sensation of joy or gladness, appetite or disgust, followed by an attempt at possession, or by a renunciation of the object in question.

Enough has now been said to show that most of the pretended primitive passions of Descartes are mere modifications of instinct, combined, even in the case of the animal kingdom, with a portion of intellect. Were we to attempt making a scale of passions and feelings, on a better plan than that philosopher, it would suffice to point the distinctive marks of our scale by reference to animal instinct, taking love and hatred as the two extremes. Were we, for example, to confine ourselves to those animals who exist only for the purpose of propagating, and with whom the sexual passion is of course predominant, we should be enabled to trace various shades of this passion in the modifications of their instinct. Again, if we look at those animals which are in harmony with the sun, and are decorated with the richest reflection of his light and colours; such as butterflies, humming-birds, pheasants, Numidian cranes, and peacocks, we shall trace in all their motions a desire to make a display of

this beauty, and to attract admiration. The peacock, in my opinion, spreads his tail less from vanity than from love; he does not, like the cock, endeavour to lord it over other birds, not even those of his own species; his affection seems merely to be directed towards the female of his kind. Birds of this beautiful class seem to have no sense of the pleasure of sound; their voice, when they have any, being extremely discordant. They may be compared to our rich *petits-maitres*, who are wholly taken up with dress, and have but a very superficial conception of the pleasure of love. The case is otherwise with those whose amorous instinct is combined with the harmonies of air: the latter do not confine themselves to a mere display of outward show, but make in their courtship an effusion of tender sentiment. Their plumage, in truth, is no ways brilliant, but they delight the ears by sounds which penetrate the heart; such are the linnet, the titling, and the nightingale. To this a humorist might compare a class of lovers among ourselves, whose mental powers are stimulated by an eagerness to attain the object of their pursuit;—those I mean, who attempt to please by calling in the aid of music, painting, or poetry, and who, alas! are often, like the birds I have mentioned, equipped in humble attire.

It has been observed, that some fishes express love by a succession of elegant movements. One of the chief enjoyments of the epicureans of the east is to have in their gardens ponds, or basins, in which there are gold, silver, and purple fishes, in great abundance. Nothing can be more pleasing than the perpetual undulations of these lively, but dumb creatures, which redouble the beauty of their little bodies by their grace, and increase the splendour of their colours by the reflection of the water. Yet I confess that, in point of grace, I prefer the motion of the small China teal, which I was in the habit of seeing at the Jardin des Plantes at Paris. These beautiful birds, the male of which is exactly like the female in point of plumage, as is the case with pigeons and turtle-doves, have little else than white, blue, or purple streaks on the head and wings, with a kind of reclining crest like that of a lark. The pond where I used to see them is very small, being little else than a cask driven into the ground and full of water; but they seemed to care very little for the narrowness of the space, and to pass their time in mutual caresses. They were perpetually swimming around each other, and bringing together their necks and beaks, which afforded so rapid a contrast of colouring that the eyes were dazzled with

the variety. They suggested the idea of a flame in the midst of water; and are better entitled than the turtle-dove to the name of the bird of Venus. A poet may say that they sprung out of the waves along with that goddess, and caressed each other at her side, while the turtle-doves were groaning on the shore. Tasso, the poet of love, had a very just feeling of the grace and effect of such motions in the midst of water, when he offers to the eyes of Rinaldo, in the garden of Armida, two beautiful nymphs who sing and contend for the prize of swimming. Homer employs the sports and songs of the Sirens to seduce Ulysses; but the favourite of Minerva, wiser than the hero of Jerusalem, escaped from their snares by stopping the ears of his companions, and by tying himself fast to the mast of his ship. Moralists of the present day would compare to these dangerous Sirens our theatrical ladies, whose seductive powers lie chiefly in the dance.

This subject might be much expanded by adverting to a number of other animals; such as quadrupeds, who offer new harmonies in their loves by the beauty and grandeur of their shape. What an ample field for description in the untamed courser, the colossal elephant, and the camelopard of the desert? But what occasion

is there to carry our researches so far as the torrid zone? This passion, this creative flame, displays an infinite variety of laws in that crowd of insects which swarm on the surface of the earth, in the forests, on the waters, and in the atmosphere. Were I to represent here the loves of the different animals which I have seen painted on the four sides of an apartment in the palace of the Elector of Saxony, at Warsaw, I should exhibit but a small number of the innumerable shades of this passion among animals, from those which, like the hog and the toad, obey the mere impulse of sensuality, to those which, like the dove and nightingale, appear to cherish a refined affection. Man unites all the gradations of this passion, and exhibits an impressive example of every kind of love from the coarse amours of the sultan in his seraglio, to the tender, the faithful, and the pure attachment of Abelard and Eloisa.

Were we to contrast with the above a picture of the animals which, like the carnivorous tribes, seem created for the work of destruction, we should find in them almost every shade and degree of hatred, in connexion with their respective instincts. But there is no such thing as cruelty among that beautiful class of animals which I call solar, from their living in the light of the sun, and particularly from their abounding in the

bosom of the torrid zone. On the other hand, nocturnal animals have all a dull or tarnished colour, and are in general mischievous. A butterfly of this description, the *sphinx atropos*, called in French *haye*, (on account of its cry,) carries the figure of a death's head on its breast, and the down which falls from its wings is very hurtful to the eyes. All birds of night, such as the bat, the owl, &c. are birds of prey: they are gloomy both as to shape and plumage. In fact it may be said that most birds of prey are birds of night; at least that their flights are taken chiefly in the morning, evening, or during moon-light. The eagle is said to contemplate the sun; but I question this, and it is well known that he seldom sees that part of the country which enjoys the benefit of the solar rays: he inhabits only the ruins of monuments, rocks, and the dry summits of lofty mountains. Poets make him the bird of Jove, because his abode is in the region of storms; but there is no doubt of his having the habit of flying during the night, as was proved by the observation of the Paris astronomer, who discovered an eagle at the end of his telescope when he was engaged in contemplating the stars. Mankind, in their weakness, have always attached a degree of distinction to whatever inspired terror; it would be difficult otherwise to account for the adoption

of the figures of the birds of prey throughout Europe for the arms of our nobility. The voice of carnivorous animals is just as disagreeable as their figures and plumage; they make the air repeat nothing but shrill or squeaking sounds. Carnivorous fishes, such as sea-dogs and thornbacks, have a livid colour and a hideous look. Carnivorous quadrupeds, like wolves, foxes, martins, &c., come out in general by night only; and their skin, though sometimes prettily speckled, as in the case of the stripes of the tiger, or the rings of the panther, commonly presents nothing but the harsh contrast of tawny and black;—colours such as we find in the wasp, and in various carnivorous insects. Moreover, all this class of animals has not only a contrast of colouring sufficient to point them out from a distance during the day, but a strong smell, which give notice of their approach in the midst of the darkest night.

I have already observed that whoever chooses to analyze the mischievous instinct of beasts of prey would find there all the shades and expressions of hatred; a cowardly appetite for the flesh of the dead in the vulture; silent cunning in the fox; treachery in the spider; horrific cries in the ospray; thirst of blood in the pole-cat; ferocity in the tiger; cruelty in the wolf; and the

fury of despotism in the lion. In the serpent, in the shark, in the sea-polypus with long arms which are provided with suckers, and in other tribes, we should find animals that grow pale at the sight of every living being; who insinuate themselves for the purpose of stinging; who crawl that they may bite; who flatter that they may tear, and hold out embraces that they may stifle; in fact, creatures full of concealed rage, and murderous, in the shape of affection, to a degree which there is a difficulty in pourtraying in the language of man, although there exist but too many examples of similar actions on the part of his species.

From the feelings or passions of animals proceed their actions, which a philosopher might call the application of instinct combined with intellect. Experience shows that their actions are the consequence of some previous thought, and, according to my theory, of thought distinct from their instinct. By instinct I mean that which they have derived from Nature; and were I to attempt an exposition of the whole process, I should say that instinct suggests an idea to an animal; intellect weighs it; and their organs, as is evident, carry it into effect. Again, considering animals in a passive sense, the process is this:—an external object produces an action on

their organs; this action creates a sensation, and the sensation an idea in their intellect.

Instinct seems to be to the soul what constitutional formation is to the body; it is that which renders it mild or harsh; industrious or stupid. Instinct has faculties in correspondence with the different organs of an animal; that of seeing, for example, in connexion with the eyes, that of loving in connexion with the heart, and that of hating in connexion with the arms with which it is provided. From this we may conclude that instinct, like the body, has some qualities which are in contrast, and others which harmonize with each other. But without proceeding farther in this discussion, it is clear that natural instinct cannot be removed either by habit after a certain time of life, nor by cutting off the organs connected with a vicious impulse. Can we take from a wolf his appetite for animal food by extracting his teeth? How cruel is then the error of those who mutilate male children under the impression of delivering them from the influence of a certain passion! The probability is that this violent deprivation has the effect of increasing, in subsequent years, that flame which it is meant to extinguish.

The instincts of animals, strange as they may appear to us, are not to be considered as deroga-

tory to the beneficence of the Divinity: they have no doubt been formed in wisdom, since they constitute a balance to each other throughout the world. Had not this equilibrium existed by a diversity of qualities, the carnivorous tribe would soon have swallowed up all the others. I take a pleasure in considering the soul (if we may so call it) of an animal inclosed in his body, along with his instinct, as a passenger in a ship with a pilot, who has the sole charge of the navigation, while the former is wholly unacquainted with it. The soul is actuated by contending feelings, and marked by a diversity which seems something like the variety of vegetables contained in a tree. An hypothesis of this nature seems to me the only one which can explain, in our species at least, the conflicts of different passions.

My object however was to counteract the notion of Descartes that animals were mere passive machines. Their actions, according to him, are stimulated only by external objects: he might just as well have said that they owed to these objects their outward shape and their inward organs. At the same time, I am far from denying to that great man the title of father of French philosophy: it was he who taught our reason to throw off the yoke of authority; but, as Voltaire said, he taught us so effectually to question the philo-

sophy of the ancients, that we have come the length of questioning his own. Nothing, at the same time, is more difficult than to find language for the explanation of systematic views in the studies of Nature, and particularly in what regards moral affections. The words used in our language are frequently either too strong or too weak, and sometimes they are inapplicable to the ideas. Our derivative and compound words do not always retain the same signification as their primitive; like certain vegetables whose stalks have different properties from their roots. In treating of instinct, I defined it a presentiment of what was suitable to an animal; but I question whether the word presentiment is sufficiently pointed to express the sure and decided impression existing in the case of most animals in the points to which I meant to allude. In like manner the word "regret" conveys a different impression from the one pointed out by its etymological analyses, *iterum gratus*. On many occasions compounds are more forcible than their primitives, "infant" meaning more than *non fans*; "injurious" than *non habens jus*; "impertinent" than *cui non pertinet*; "impious" than *non pius*. Other remarks might be added, with examples of the preposition *in* producing at times a contrary effect in words to which it serves as a compound;

for, though generally negative, it has sometimes an affirmative sense; but as these are confined chiefly to French, I shall decline enlarging on them, and shall merely apprize my readers that my plan is to separate, by a small stroke, a compound word from its preposition when it is necessary to use it in its primitive signification; an expedient more convenient than a circumlocution, and less strange than the introduction of a new phrase.

Naturalists, in using collective words, are apt to speak of the "kingdoms of Nature, of classes, orders, families, genera, species, and varieties," in a manner which seems to me productive of considerable confusion. A "kingdom of Nature" is an appropriate expression only when speaking of the power of God; a "class" means merely an accumulation which belongs as much to a genus as to an order. Again, "order" is a general word applicable to whatever is destined or understood for a specific purpose. "Family" conveys the idea of consanguinity, and is more suitable to individuals of the same variety; to varieties of the same species, and to species of the same genus, than to approximate genera, to which it is applied, although the latter have less resemblance to each other. The word "genus" has, however, a more determinate signification, inasmuch as the

species are engendered by, or derived from it. I have endeavoured to substitute, for most of these names, the terms "power, harmony, genus, and species."

Notwithstanding the obscurity arising from our deficiency in appropriate words and the prejudices of early habits, I shall not be discouraged from endeavouring to convey an idea of animal power, and of its progressive extension. As the first navigators, who ventured to sea without compass or quadrant, succeeded in discovering parts of the globe by letting fly, from time to time, a bird to guide them by its flight and its instinct towards such lands as they could not perceive on their horizon; in like manner, by consulting the instinct of animals, we may find it practicable to make some discoveries in the immense sphere of life. It was thus that Noah was enabled, under a cloudy sky, to judge, by the flight of the raven and of the dove, of the condition of the earth after the waters of the deluge had begun to subside. It was particularly the bird of love which, by bringing him back a green olive branch, satisfied him that the mountains were beginning to appear above the water, and to become habitable. We shall guide ourselves by a similar clue in our inquiries after the basis of the animal, and even of the human power.

The sun and moon exercise great influence on the early part of animal life; pregnancy, birth, growth, love, and death, being regulated in almost every species by the different phases and periods of these orbs. The soul of an animal seems to combine, to a certain extent, the faculties of intelligence and reflection. It would not be enough for it to have an impression of its wants by instinct or intelligence; for such impressions, if not carried farther by reflection, (at least that degree of reflection of which it is capable), would be like an image in a mirror. It ought not to appear more extraordinary in our eyes that the soul of an animal should be made up of those mixed parts, than that various vegetables should be found under the same bark.

Taking the word soul in the sense of *principle of life*, we find, in all, five distinctions, viz. the elementary, the vegetable, the animal, the intelligent, and the celestial. The first four belong to all animals down to the smallest insect, while the fifth is confined to man. By the elementary soul of animals, I mean attraction, a property which they have in common with substances of all kinds. Attraction, in the sense in which I now use it, seems adhesive to all kinds of matter; it operates on the ray of light which it turns towards the angle of a body brought near it; it rounds into

the shape of a drop of rain the vapour which swims in air, or it crystallizes it into a flake of snow. It accumulates in the bosom of the earth grains of sand into crystal, and metals into pyrites; raises the sap in the capillary vessels of vegetables, and circulates the blood in the veins of animals. It acts particularly on their sinews, of which it seems to be the first mover; it appears to compose or decompose itself into magnetism, electricity, fire, and light. The grand focus of attraction is the sun, who exercises it on all the planetary bodies which he causes to turn round him. The latter become penetrated with it, and communicate it in like manner to the satellites which turn round them; while the whole apply its operation to the substances which are fixed on their circumference by gravity, as well as to those which move on it like animals. Among reservoirs, and conductors of attraction, we reckon chiefly the planetary bodies in the firmament, and on earth metallic substances. The two appear to harmonize, gold having been long since considered in relation with the solar rays, as silver with those of the moon. In treating of solar harmonies, I have mentioned the relations of other metals with the other planets, and I am now to add, merely as an anecdote, that platina, which for us is a metal of pure curiosity, was dis-

covered nearly at the same time as the *Georgium Sidus* of Herschell.

By adverting to the imagined relation between the sun and gold, I may be thought to renew old errors, but I do no more than follow the traces of the ancient temple of science. Moreover, there exists a connexion in almost every department of Nature. The concentric layers of so small a plant as an onion are in harmony with the lunar months, in the same way as those of a tree are with the solar rays. At this rate why should it be accounted ridiculous to make similar observations on gold and silver? Many metals possess, like planets, well known powers of attraction; gold attracting Mercury, which the sun volatilizes, and the load-stone attracting iron.

It seems then an established point that metals have an analogy with planets by their weight, their splendour, and their attractive powers; they have the same by means of their electricity, of which the sun is the source. They are not only its conductors, but its permanent receptacles, as has been proved by galvanic experiments, of which we shall treat forthwith. Meantime let us remark that electricity is a fiery fluid, often not apparent, circulating in all bodies, and passing from those which have a large, to those which have a smaller quantity. It is divided by its

effects into positive and negative electricity, and perhaps it might with propriety be divided into active and passive. It seems one of the primary impulses of vegetation, and animation. It is after the most awful storms that vegetables come into flower, and bear their fruits with the greatest vigour. It is then, likewise, that the generations of insects multiply with so much rapidity as to make the vulgar imagine that they have fallen from the firmament. Electricity seems to be the torch of love: it kindles its fires at the age when animals have attained their growth. Electric fire may be distinguished into soli-lunar, and luni-solar; the former exists in male animals, and is displayed in the ornaments of their bodies, decked as they are in lively colours, particularly in the male sex. The same is apparent in carnivorous birds and beasts, whose eyes sparkle in the dark, and whose hairy covering is apt to bristle and to wear a luminous aspect.

I am inclined to think that electricity is communicated to plants by means of metallic substances. Without dwelling on extraordinary appearances, such as that of the vine-stock of Tokay in Hungary, which had grown on a gold mine, and in the leaves of which were found threads of gold, I may be allowed to quote the experiments made by a number of naturalists, and among

others by the celebrated Geoffroi: they prove that there is not a single vegetable whose ashes do not contain some ferruginous substance. It is natural to imagine that this metal, which in mineral water is dissolved into invisible particles, should be mixed with the sap of vegetables; and as we also know that it is one of the most powerful conductors of electricity, we may, without being chargeable with a predilection for theory, consider it as the cause of its phenomena in vegetation. It appears particularly in red flowers; for it is it which gives them their colour, as I have experienced in the case of a rose.

Ferruginous particles are found to exist even in animals: they are said to be contained in their blood, and the blue colour taken by bullock's blood after being burned, and becoming what we call Prussian-blue, is ascribed to this admixture. Certain it is that particles of iron have the effect of giving a red and blue colour to vegetables, and that they are operative in producing mixed colours, such as orange, purple, and violet. To these we we may add the colour of black, as is shown by the dye resulting from a mixture of gall-nuts and iron.

The discovery of the fact of iron entering into the composition of vegetables and animals was made by reducing them to ashes, and to the application of the loadstone. Had similar expe-

riments been made on them with Mercury, the loadstone of gold, we might perhaps have found in them particles of that metal. Yellow coloured vegetables and products appear to me to owe their hue to a tinge of gold. I used to see M. Sage, the well known chemist, make experiments on the red part of flowers, on wine, and on blood; and I have heard him say that a yellow colour in stones was indicative of the presence of gold. Why should it not, in like manner, be indicative of the presence of that rich metal in vegetables and animals? It is the colour of the sun, or at least the first decomposition of his rays, which appear in volatilized gold. I have already stated that the diamond was a concretion formed, in the course of ages, by his rays, and I hazarded that opinion on finding that, on burning a diamond in a crucible, it left no residue of matter. A late experiment of M. Morveau, the chemist, gives as a residuum a carbonic acid by which he succeeded in making steel, and from which he concludes that the diamond is a species of coal. In my opinion, however, it remains to be discovered whether it was the fire of the experimenting process, or the sun's heat, which gave it this character. In the latter supposition, it would be formed by the continued operation of the sun's rays in the way I have mentioned above, and gold appears to me to be a concretion gene-

rated in the same way. But whatever be the origin of either substance, certain it is that gold and diamonds are discovered only in hot climates; and if it be objected that mines of gold are sometimes found beyond the present line of the tropics, the answer is that these mines may possibly have been within the tropics in a former age, when the position of the poles was not as at present. The argument here rests on the same foundation as the one relative to the fossil remains of vegetables and animals of the torrid zone. Siberia contains mines of gold, but it has also fragments of palm-trees along with the skeletons and teeth of elephants. As to diamonds, I have not heard that they have as yet been found either in the temperate or frozen zone, for want perhaps of being looked after. A diamond in the rough does not strike the eye with the brilliancy of gold, for it resembles in fact a grain of salt; but it has this in common with gold, that it is the heaviest of all non-metallic stones, in the same way that gold is the heaviest of metals.

If then the earth serves as a matrix of gold in the part where solar influence is most active, why should not animals and vegetables, receiving as they do the solar rays, and combining particles of fire with their proper substance, be found likewise to contain particles of gold as well as of

iron? It is very remarkable that the yellow colour, which indicates gold in stones, appears in most of the germina of seeds, and particularly in the yellow dust of the anthers which serves to impregnate flowers. Almost all anthers are yellow, and they are placed in the heart of a reflector formed by petals, the curves of which reflect on these masculine parts all the influence of the solar rays. On the other hand, the feminine parts, viz. the stigmata or openings of the pistil, are white, and seem to establish by their colour other relations with the influence of the lunar rays. The flowers of some plants, among others the great monkshood, appear phosphoric during night; and finally, when vegetables undergo decomposition, the fires which they have imbibed appear to become disengaged, and to show themselves in a bluish glimmer—such is the fire of rotten wood.

Similar effects of light and electricity may be discovered in animals. Their brain and sinews are of a white mixed with yellow; and their sinews, like threads of gold and silver, are powerful conductors of electricity. Those which end at their eyes make these organs sometimes sparkle in transports of love or rage. Finally, in the dissolution of animals, the particles of light which entered into their composition are displayed in

phosphoric glimmerings, especially in sea-fish, because the sea is the great receptacle of the elements. It is so strongly impregnated with the element of fire, between the tropics, as to appear luminous during the night; and, when in winter its waters flow from the torrid zone towards our poles, they not only soften the rigour of winter in our atmosphere, but they are perhaps one of the causes of these Auroræ Boreales, which, during winter, enliven the gloom of night in the north, and which do not appear there until after the autumnal equinox, the date of the revolution of the sea from south to north.

Not only do attraction, magnetism, electricity, and light, reside in metals, vegetables, and animals; but the fire which produces them is naturally there and in a state of repose. Swedish naturalists have produced, by the mere rubbing together of two plates of iron, a degree of heat which makes water boil without causing any discernible wear of the metal. This seems a new method of procuring heat. As to wood, there can be no doubt of its containing a great proportion of fiery particles, since it is found so convenient a supply for our hearths. As to animals, their warmth seems a sufficient indication of the fire that vivifies and enlivens them. With this man seems the best provided; his natural heat being equal

to that which hatches the eggs of birds. He may easily augment this heat by rubbing one part of his body against another, when the result is very similar to that of the two iron plates of the Swedish naturalists. This coincidence may be adduced as an additional proof of the resemblance of nerves to metals; both are conductors and receptacles of electricity, as we shall see in treating of galvanic experiments.

Along with its elementary life, an animal has a vegetable life of a very distinct character. Supposing for a moment that it had none but an elementary life, it might put its whole body in the shape of a ball by its attraction; in the shape of an aigrette, by its electricity, or in any other shape analogous to that of crystals or pyrites. But its vegetable principle of life seems to exercise a kind of control over the other, and may be compared to a mason served by an apprentice, who hands him materials, leaving him to place them in that regular order which is necessary to raise an edifice. This vegetable principle organizes the body of an animal as well as that of a vegetable product, but in a manner that is both more systematic and more complex. It is to its operation that I am inclined to attribute the original formation of the fœtus in two halves perfectly similar; as well as the subsequent de-

velopement of the little frame. A child, on seeing the light, is so completely formed as to have its breathing and the circulation of its blood carried on without the slightest interruption even in sleep. The same holds in regard to diet and digestion, and if an accidental injury be received, the little wound is soon healed by Nature covering it with a new skin. In some animals, Nature goes farther, and restores entire members, as may be seen in the case of crabs, whose toes shoot out again provided with all their apparatus of joints and claws. Nature thus gives new arms to those crustacea in the same way that she gives new branches to trees. Nay, she produces on the bodies of animals several kinds of vegetable substances, which however bear neither flower nor fruit, as hair, feathers, shells, nails, horns. Each of these modes of vegetation has its particular laws; the smooth horns of cattle being permanent, while the antlers of the stag fall off every year.

Nature varies almost to infinity the shapes of animals, but she never deviates from the laws of harmony and contrast, which make each of them consist of two halves perfectly similar, as well as of two halves of an altogether opposite character. The loves of animals, like those of vegetables, are regulated by the different periods of the sun

and moon. Love is a flame which, like that of fire, admits of being communicated and multiplied without becoming enfeebled. The earth, in its daily and annual progress, lays open in a spiral form the circumference of its two hemispheres, which the sun surrounds with his rays as with threads of gold stretched on a machine. The moon crosses them like a celestial shuttle, and binds them together with her silver streaks. The vegetable and animal world feel this influence and come forth, grow, and perpetuate their species by these soli-lunar, and luni-solar harmonies. The process is not laid open to our observation in its extent, but there seems no reason to doubt its reality, and still less to question its being the work of a Divine Superintendant. It was he who created and organized various seeds to compose the future world, and who gave to the orbs of day and night the power of calling them into life and motion. Were we at liberty to compare the feeble efforts of man with the dispensations of the Supreme Being, we might say that these mechanical or vegetable principles of life resembled machines planned by a skilful artist, the powers of which, when put in motion by the action of fire, or by the course of winds and streams, express liquors, pulverise grains, give a shape to planks, and even

impress a legend on a metallic substance, without any consciousness, on the part of this elegant and efficient machinery, of the operations to which it is subservient.

The human body contains a number of beauties which are but partially distributed to other animals; its stature and strength are fixed with admirable proportion. Of this we shall treat more fully in discussing the properties of our bodies under the head of human harmonies.

I now come to say a few words on what may be called the animal soul or living principle, by which I mean the sentiment of existence, the consciousness of the possession of organs, and the desire of providing food. It is susceptible of pleasure and pain through the medium of the nerves dispersed through the whole body, and particularly towards the skin. It is by touching their extremities that the warning of pressure or danger is received, but they lose all sense of feeling if they happen to be paralysed. A philosophic investigator would consider the heart of animals as not only the central point of sensation, but the seat of instinct and of the feelings connected with it. Of these feelings, the principal is self love, which, in each animal, is decomposed, as I have already observed, into a desire of ob-

taining what suits, and of avoiding what does not suit him.

In comparing animals of opposite characters, such, for example, as the lamb and the wolf, we find perfect similarity in regard to what may be called the elementary principles of life; I mean in regard to their nutrition, digestion, circulation of the blood, &c. the only material distinction being that the one lives on grass, and the other on flesh. The difference of character, and a very great difference it is, consists in what I call the animal principle of life and its consequent instinct. That of the wolf points, from the beginning, to flesh and blood, while that of the lamb rests with complacency on tender grass and limpid streams. The instinct of the wolf is materially different from that of the dog, notwithstanding the resemblance of their bodies. No mode of education, no length of time, can, as far as we yet know, induce the wolf to approach the habitation of man—he bears from his youth upward a marked and a permanent character. It is this character which gives ferocious features to his look; features which our inattentive eyes sometimes confound with the rough look of a shepherd's dog; but a lamb never falls into such a mistake; it distinguishes at the first glance, and at the first scent, its tyrant from its protector.

Why, may it be asked, should it have entered into the plan of Providence to give existence to such hatred and to such attachment? I do not pretend to account for it; but I see that the result is good, and that it bears a useful relation to man. Certain it is, that the animals who live on fruits and grass would soon despoil the earth of its plants, were not the progress of their population arrested by beasts of prey. The latter again would accomplish the destruction of other species of animals, did not man, in his turn, prove a formidable obstacle to their multiplication. Perhaps on maturely examining this sanguinary struggle, we may find reasons for exempting Nature from the charge of injustice and cruelty. By permitting one animal to devour another, she does not take away, as in the case of a robber in regard to a man, a life which does not belong to her. It was she who gave and who may take back; she draws from the river of life an infinity of streams which she has scattered over the earth, and which she may again cast into a larger flood. Death to an animal is but a modification of its existence; its life is transported from its body to that which devoured it; but the soul which animated it has, we may be assured, a different destination. Does the wolf acquire any thing of the tenderness of the lamb which he devours?

Or does not the blood of the little innocent only increase the cruel thirst of its tyrant? What then, it may be asked, becomes eventually of the gentle soul of the one, and of the ferocious soul of the other? To this, I confess I am unable to give an answer; but I am not prepared to treat with ridicule the Hindoo notion of metempsychosis. The Hindoos imagine that the soul passes after death into the body of animals, and that the transformation is regulated by the passions which have predominated during life; the souls of the cruel going into the tiger and lion; those of the deceitful into the fox and serpent; those of the glutton, into the hog, &c. Certain it is that man combines in himself the passions of all these animals, and that that which predominates, whether from Nature or habit, becomes displayed in his physiognomy by something like the features of the animal of which it is characteristic. Some physiognomists say that the expression of the countenance is best ascertained by putting the hand on the mouth, and by leaving only the forehead, the eyes, and nose, uncovered. Baptista Porta was in the habit of drawing human countenances which bore a very evident resemblance to the ox, the tiger, the hog, &c. Mirabeau, so well known in the early scenes of our revolution, had, in his large head, small eyes, and

prominent jaw bones, something not unlike the head of a boar. I have seen a woman with a large turned up nose, and a small red mouth, extremely like a paroquet. Finally, man and woman are subject to the passions of animals as well as to their diseases; they are susceptible likewise of their enjoyments; and the sun and moon have here also their influence in regulating the different periods of their appearance.

I shall next say a few words on that portion of intellect which appears to be possessed by animals. The ant is, like the bee, fond of honey; but it does not gather it in flowers, or attempt to make a hive in its little cave; it employs itself altogether in collecting those fragments of vegetables and animals for which Nature intended it. This discrimination, brief as it is, may suffice to convey an idea of my meaning, which is that the instinct of animals is more complex than is generally supposed, and may be analyzed in ways which do not always strike the observer of Nature.

From this attempt to describe animal instinct, I turn with pleasure to a higher theme; I mean to the faculties of our own species. Man alone unites those qualities which we find scattered throughout the various tribes of the animal kingdom. He is capable of industry as well as of enjoyment in every shape, and he, alone of all created beings

in this world, has an impression of divine power. While the instinct of other creatures attaches them merely to a particular spot, or to a particular food, that of man teaches him to look up towards his Creator. This feeling is innate and extends his view beyond his horizon and his term of life: it is common to the savage and to the civilized. It is to the belief of the existence of a God that man owes the idea of infinity, universality, glory, and immortality, which, harmonizing with his understanding, have been the causes of enabling him to make such progress in art and science, and of giving so much scope to his feelings. It is to this belief of a superintending Providence that he owes his consciousness of virtue, and that he is induced to regulate the gratification of his desires by a consideration of what he owes to his equals. This instinct towards heaven, this conviction of the existence of a Supreme Being, an avenger and remunerator, is the natural foundation of all human society. Man has also what may be called animal instinct; I mean his sympathies and antipathies, his attachment to, and aversion from, certain situations, all of which are productive of exertions more or less successful, and of a display of talents more or less conspicuous. These sentiments are innate, and no education can entirely alter them; but

that which governs him, when in the bosom o. nature, is the impression already mentioned oi Divine Power. I repeat that it is probably to this impression that he owes the chief part ot that knowledge which renders him so superior to other creatures. At all events it is certain that the wisest of mankind, such as Socrates, Plato, Newton, and other kindred philosophers, have been remarkable for devotion.

I shall enlarge on the effects of religious impressions when treating of human harmonies; at present I am to add a few observations on the instinct of animals. I may be supposed to have attempted too much subdivision, and to have enumerated more qualities than can be contained in such humble bodies. But if a variety of colours are contained in a single ray of light, if fire possesses several distinct qualities, the atmosphere more than one species of air, and the vegetable various plants under the same bark, why should a similar latitude not be supposed to exist in the case of animals? Let us take, as the lowest extreme of animal life, the earth-worm, which seems inferior to the apparently torpid oyster, and let us ascend from this humble insect all the way to the lords of the creation. We should thus be enabled to compare all the shades of intellect in animals destined to float on the

ocean of life, with the various attempts made by man to navigate the real waters, from the floating trunk which enables a savage to cross a river, to the gallant vessel, constructed with all the skill of advanced science, and prepared to circumnavigate the globe. In the long list that intervenes, we shall find the raft, the canoe, the yawl, the shallop, the schooner, the brigantine, the frigate, and we arrive at last at our largest ships of war bearing more than a hundred cannon. So much by way of giving us an idea of the various progressive steps of animals in a corporeal point of view. As to the portion of intellect possessed by them, the elementary part may be represented by such labour as that of the miner, the woodman, the weaver, and rope-maker, who supply the rough materials for a vessel, without comprehending the use that is to be made of them; while a less humble portion of animal intellect may be exhibited by the work of the smith, the carpenter, or the caulker, who proceed in conformity to prescribed rules. A third part of what I have called the animal soul may be conceived by a comparison with a ship's company, each stationed at his post, and ready to obey orders; while the highest step in the scale may be represented by the pilot standing at the helm, and guiding the motion of the vessel. But were

I to attempt giving in this manner an idea of human intellect, I should compare it to the master of a ship, the sole depository of the secret object of the voyage, and I should suppose him issuing out daily directions to his humble followers. The comparison might be extended by describing the implicit obedience with which the will of the master is received; and the delineation of disorder, when it occurred among the members of such a company, might be rendered illustrative of the tumults of the human mind.—When man listens to his passions, his resolutions are shaken by the most contrary impulses. Cupidity says, "It is to me that the enjoyment of every thing belongs:" ambition exclaims, "Renown is my portion;" while pride calls out to unassuming virtue, "Thou art nothing more than illusion." Too often does it happen that the mind, seduced by their confident assertions, listens to their voice, and endeavours to seek a justification of its errors in the example of the past.

Not only are physical harmonies subordinate to the faculties I have endeavoured to describe;—the moral harmonies are so likewise. It will suffice at present to quote the first of these; I mean fraternal harmony. It is it that gives to an animal that profile and countenance which is characteristic of each species; which, in the groveling attitude of

the hog, is expressive of gluttony; in the lion, of ferocity; in the turtle dove, of grace and love. These profiles have the same expression in each genus of animals, but they vary almost infinitely in man, according to the particular passion that governs him. We may trace, in the interior as well as the exterior profile, the sensoria of all the organs of an animal, beginning with those of the pineal gland, and observing successively those of the optic and olfactory nerves, those of breathing, hearing, drinking, and eating. When the cruel operation of cutting an insect, or other animal, across, is performed, life is observed to remain for some time in the two divided parts. The head of a fly separated from its body gives, for a considerable time, tokens of life, and the body is still capable of hovering over various spots; but if the insect be cut in two length-wise, it perishes almost instantaneously. Its living principle is like a flame proceeding from two torches held close together, and vanishing as soon as they are separated. Hence I have called it a fraternal harmony of the two halves of the body.

In considering the different looks of animals, it is fit to remark that the most unpleasant appearance is given to those who are hurtful or inconvenient to man, and the most comely to those who are destined to live in his neighbourhood, or

under his control. The wolf has a bristled skin and staring eyes; while the lamb is clothed with a soft fleece, and the horse has a smooth back, stately neck, and flowing mane. The pigeon and the cock have each considerable elegance of shape, and the dog seems destined for caresses by the softness of his skin; but the beauty of almost every animal is found united in our own species, in the male, and still more in the female form. The growth of animals is calculated by the revolutions of the earth round the sun, and is dependant, although indirectly, on the influence of the rays of that luminary on this lower world. The animal kingdom depends for support on the vegetable kingdom, which derives its growth and increase entirely from the sun, that sphere of moving and living fire, which contains within itself attractions and repulsions of every kind, which has colours of every description in its light, and every degree of temperature in its rays.

If we pursue our inquiries farther, and attend to the final decomposition of the elementary parts of vegetables and animals, we shall be enabled to trace a chain of connexion, of which the ordinary spectator is seldom aware. The weight of a substance is not annihilated because that body is reduced to powder; it remains divided among each of its parts, and continues to form a portion

of the total weight of the globe. The case is the same in regard to electricity: it circulates from one body to another, where it is sometimes positive, sometimes negative, according to the greater or less quantity in which it exists there relatively to another body. It fixes itself in metals, which are not merely powerful conductors, but constant reservoirs for it. It affects even the muscles of animals, and may be traced there for some time after their death. This resemblance between electricity, metals, and muscular fibres, leads me to speak of some experiments of a very singular description. An Italian physician, named Galvani, who has now been dead a number of years, was the discoverer of the direct influence of the electricity of metals on the muscles of animals after death, and the experiments which are now made very frequently in that way are consequently called galvanic. I have seen an experiment made on the body of a frog, twenty-four hours after its death. When the little animal was dead, it was cut across in two, the intestines taken out, and the extremity of the muscles of the thigh separated from the back; the uncovered muscle was then wrapped entirely round with a small silver leaf. During all these operations, not the smallest sign of motion was manifested by the remains of the frog, although an iron knife was made use of;

but as soon as the professor took a small plate of tin, and, after supporting one of its ends on a plate of silver, touched with the middle of the plate the end of the uncovered muscle, the fragment of the frog sprung immediately on the table, and continued to do so several times, as if it had been still in life. Galvani repeated these movements by raising with one hand the fragment of the animal in the air by the end of one of its feet, and applying his apparatus in the other;—the separated member of the frog continued to move in a quick and lively manner so long as it felt the touch of the tin plate, in connexion with the silver plate, and the end of the muscles.

The professor next showed us that two parts of the same metal put in contact, such as silver on silver, produced no effect on the frog's muscles. He proceeded next to make us experience, personally, another effect of the harmony of two different metals. We put on our tongues a piece of silver, or a piece of tin, without experiencing any sensation, but on placing these two pieces one above the other, so that the tongue touched them at their point of contact, we experienced a very particular taste. Besides, on putting the silver and tin above and below the tongue, so that they touched each other at the extremity, a kind of flash is immediately perceived; this is an electric shock

on a small scale. All metals, on coming thus in contact, produce an effect of that nature, provided they are of distinct species, such as copper and iron, and particularly if they are gold and silver.

These experiments are generally considered nothing more than objects of curiosity; but I cannot help looking on them as the entrance to a large field in the domain of nature. They seem to justify the conclusion that the soli-lunar and luni-solar harmonies, of which we have hitherto treated, are not only diffused throughout the elementary powers of Nature, but that their attractive and electric qualities are concentrated and deposited in the metals which are analogous to them, and which are not merely their conductors but their reservoirs.

We may farther infer that metallic, as well as planetary harmonies, discover their influence on our sinews, when these metals are harmonized two and two; and that our sinews are themselves the conductors and reservoirs of such influence, by means either of their own substance, or of the metallic particles which they contain. Since the muscles of animals discover, after death, a sensibility to the metallic harmonies of tin and silver, copper and iron, lead and copper, gold and silver, why should we refuse to believe that they experience, during life, the planetary harmonies analogous to

these metals? This may be called the idea of a remote age, but it is certain that fraternal harmonies exist in the influence of the sun and moon, as we have shown when treating of the growth of vegetable products. A portion of electric fire appears not only in the living principle of vegetables and animals, but may even be traced after death in their decomposition. It is in this way that I am disposed to account for that phosphoric and bluish light which we see at night in rotten wood, and in dead bodies in a dissolved state; but it is particularly in the sea, the scene of all such dissolutions, that we observe, above all in hot seasons, and between the tropics, an infinite number of small phosphoric bodies, which during the night make the waves in a manner sparkle with light. These luminous corpuscula appear, even in a time of calm, to be shaken in all directions. Can they be the organic molecules which, according to Buffon, are scattered throughout the universe?

The relics and refuse of vegetables are used, as is well known, for the purpose of manure, and of rearing a new supply of the same kind of products. In regard to corn, it is a settled point that cropping must not be long continued on the same spot. The country people are in the habit of saying that it does not in that case find a

proper juice; yet the field, though exhausted, is not barren, as is evident by its fitness to produce other plants. This circumstance suggests to me a similar observation in regard to insects. After any particular year has produced a great number, there are generally very few in the next, although, judging by analogy, we should imagine that the multiplication of their numbers would go on with increased rapidity. Notwithstanding these checks to the increase of particular portions of the animal or vegetable kingdom, there seems, on the whole, a progressive increase of vegetable matter. The covering of soil, extending over the surface of the earth, seems to receive from the remains of plants an augmentation which, though small, is not altogether imperceptible; while madrepores and shell-fish appear, as far as we can trace the operations of Nature under the waves of the ocean, to form new beds of stone, plaster, and marble, out of the various fragments exposed to the action of the water.

The advocates of the doctrine of transmigration may be disposed to ascribe to the power of recollection the innate foresight of animals in regard to a life on which they have barely entered. Their instinct in regard to the future may appear, to those who adopt the Hindoo notion, little else than an experience acquired in a preceding life.

They may allege that it is only by supposing such transmigrations that we can succeed in explaining those sympathies and antipathies which are apparent almost from the moment of birth. Be this as it may, the instinct of an animal will be found to differ from the intellect of man much more in regard to the compass of its objects, than to the accuracy of its perception. It may be considered a point, or a ray of that universal sphere of which man occupies the centre and God the circumference. A slight reflection of the light of day suffices for the labours of the bee in his dark hive. Man calls in, to aid his nocturnal labours, the flame of the fiery element; but the Author of Nature illuminates worlds and systems of worlds by means of suns. A bee makes its hexagonal cell with as much geometric skill as Newton, but it will never attempt a different kind of figure: never will it be capable of imitating the screw in which shell-fish are contained, nor even the concave segment in which the rose offers to it its nectarine glands. Nor does it stand in need of such imitations; small cells with six little sides being sufficient for the deposit of its honey. But a soul, such as that of Newton, has wants of a higher kind; it traces on earth the curves described by the stars in the firmament; extends itself with them into infinite

space, and is overcome only by the awful idea of Him who has created the Universe.

I return with pleasure to consider the effects of religious impressions on man. It is a conviction of the superintendence of a Divine Providence that spreads on those features, which are not yet disfigured by passion, the charm of innocence, beneficence, justice, and heroism. This is the source of his improvements in art and science, and particularly of those which have successively subjected to his sway the most formidable of the animal creation;—the lordly bull, the stately horse, the colossal elephant. If it sometimes allows itself to become subject to the influence of feeling of a far inferior kind, it gives them at least the impression of infinitude, universality, and of a future existence; but if it retains them under its control, it enables man to direct his eyes steadily to that Heaven, whence it proceeded, and whither it hopes to return. It is this contest, supported as it is by such dignified hopes, that constitutes virtue.

Passions may have the effect of varying almost infinitely the looks of man, since his nature admits of the prevalence of almost every kind of impression. In a mixed assembly, a physiognomist may imagine that he treaces the features of the most artful or cruel animals. Animals differ

from man in this respect, in as much as each species may be said to possess only one kind of expression. It is by the portion of our nature which resembles the lower part of the creation that we are led into contentions and wars;—it is by the celestial portion of our soul that we are brought back to peace. But whither goes this our better portion, when separated from its tenement of clay? To one of the seven orbs or seats of paradise, says the Hindoo, provided its career in this lower world has been virtuous.

END OF VOL. II.

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